frontiers | Research Topics

Research in social psychology, prevention activities and mental health promotion, 2nd edition

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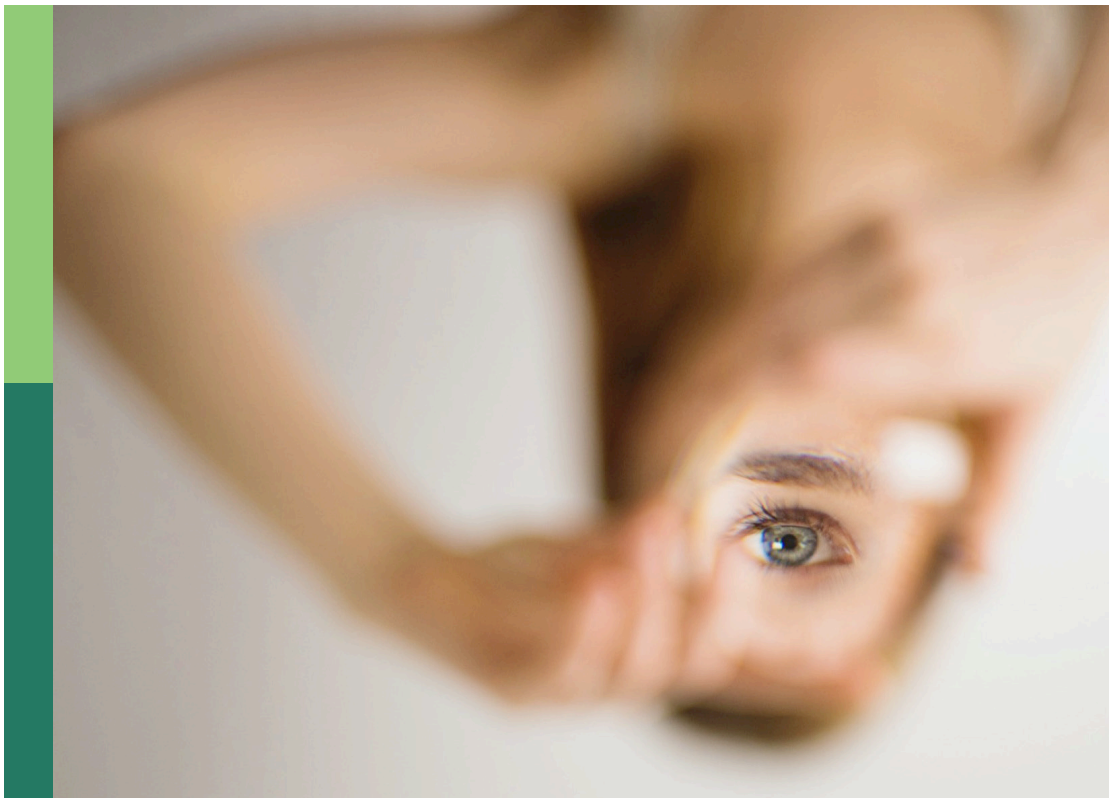
Published in
Frontiers in Psychology
Frontiers in Sports and Active Living
Frontiers in Public Health



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ISSN 1664-8714
ISBN 978-2-8325-5841-6
DOI 10.3389/978-2-8325-5841-6

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Research in social psychology, prevention activities and mental health promotion, 2nd edition

Topic editors

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Citation

García, S. L., Moral-García, J. E., Loureiro, M. J., González-Palomares, A., Ruibal-Lista, B., eds. (2024). *Research in social psychology, prevention activities and mental health promotion, 2nd edition*. Lausanne: Frontiers Media SA. doi: 10.3389/978-2-8325-5841-6

Publisher's note: This is a 2nd edition due to an article addition.

Table of contents

frontiers | Frontiers in Psychology

TYPE Editorial
PUBLISHED 23 February 2024
DOI 10.3389/fpsyg.2024.1373715

Check for updates

OPEN ACCESS

EDITED AND REVIEWED BY
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RECEIVED 20 January 2024
ACCEPTED 12 February 2024
PUBLISHED 23 February 2024

CITATION
Ruibal-Lista B, Moral-García JE, González-Palomares A, Loureiro M and López-García S (2024) Editorial: Research in social psychology, prevention activities and mental health promotion.
Front. Psychol. 15:1373715.
doi: 10.3389/fpsyg.2024.1373715

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Editorial: Research in social psychology, prevention activities and mental health promotion

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KEYWORDS

editorial, research, exercise, social promotion, prevention activities and mental health promotion

Editorial on the Research Topic
Research in social psychology, prevention activities and mental health promotion

As guest editors for Frontiers in Psychology, we are honored to present the outcomes of the Research Topic entitled "*Research in social psychology, prevention activities, and mental health promotion.*" This scientific compendium is designed to underscore the significance of regular physical activity in combating sedentary lifestyles and promoting overall health.

This Research Topic not only seeks to emphasize the importance of physical activity in mental health but also addresses the necessity of social policies promoting healthy habits from various perspectives: preventive, educational, economic, and social. It emphasizes that these policies should not be seen as a cost but rather as a crucial investment in the health and quality of life of society as a whole.

Researchers and educators were invited to contribute innovative research in the field of healthy habits, physical activity, and social psychology. The goal was to publish rigorous scientific articles that provide new insights into promoting healthy lifestyles and physical fitness, while also advocating for preventive measures and improving the quality of life across all age groups.

The Research Topic has achieved remarkable figures; shortly after closing, 16 articles involving 55 authors have been published, accumulating over 23,000 reads and around 4,000 full articles downloads. Finally, it is important to highlight the demand for the quality of the publications. In total, 73 manuscripts were submitted and 16 were accepted, so the publication rate is around 22%.

Due to the substantial number of articles, we have decided to categorize their conclusions into three sections:

Section 1 - Studies on social behaviors, isolation, depression, and suicide

Ikenouchi et al.'s *"Effect of the personality traits of healthy Japanese workers on depressive symptoms and social adaptation, and on the achievement rate of exercise therapy to prevent major depression"*: these authors demonstrated that depressive symptoms and social adaptation were differently associated with personality traits and success rates before and after exercise therapy.

Xing et al.'s *"Exercise adherence and suicidal ideation of Chinese college students: a chain mediation model test"*: among other findings, they showed that physical exercise can directly predict suicidal ideation in Chinese college students.

Wang et al.'s *"From experience to expectation: The reverse effect of power on purchasing impulsiveness"*: this research presents a new theoretical perspective on the relationship between power and purchasing impulsivity, proposing a power experience-expectation model that suggests consumer purchasing impulsivity is influenced by both experience and power expectations.

Wu et al.'s *"Consistency in personality trait judgments across online chatting and offline conversation"*: participants consistently judged individuals in terms of empathy and the Big Five personality traits in both online chat and offline conversation contexts. These findings contribute to understanding how people are perceived across different environments.

Yamaguchi et al.'s *"The influence of vulnerability on depression among Japanese university athletes"*: this study observed that appropriate psychological support in athletes can reduce depression and improve mental health, especially in those with higher vulnerability levels.

Yi and Li "*The influence of local government competition on residents' perceptions of social fairness—Evidence from China*": results indicate that such competition broadens the perception of social injustice, influencing through income disparity, reduction of public goods, and an increase in corruption. These findings have practical implications for promoting common prosperity and strengthening the capacity of local government.

Section 2 - Social relationships among youth, social relationships in the elderly, and compulsive internet and smartphone use

Parti "*What is a capable guardian to older fraud victims? Comparison of younger and older victims' characteristics of online fraud utilizing routine activity theory*": it was observed that computer usage time influences young people's vulnerability to online fraud. However, older individuals are less likely to employ technical protections, such as covering cameras, monitoring identity theft, and freezing credit cards, and are less likely to report scams.

Zhao and Zheng *"The effect of peer victimization on adolescents' revenge: the roles of hostility attribution bias and rumination tendency"*: results suggest that peer victimization is positively related to revenge, with this relationship being stronger in individuals with a tendency toward concrete experiential rumination than in those with abstract analytical tendencies.

Liu et al.'s "*Effect of physical exercise on social adaptability of college students: Chain intermediary effect of social-emotional competency and self-esteem*": the authors observed that physical exercise not only directly affects college students' social adaptation but also has an indirect effect through the independent mediating role of social-emotional competence and self-esteem.

Huang et al.'s *"The relationship between sense of community and general well-being of Chinese older adults: A moderated mediation model"*: findings suggest that fostering community participation can enhance the overall wellbeing of older adults, contributing to building stronger societies in Chinese cities.

Wanqing et al.'s *"Smartphone addiction and cross-cultural adjustment among overseas Chinese students: The role of emotion regulation beliefs and strategies"*: this study demonstrates the correlation between emotion regulation beliefs regarding smartphone addiction and cross-cultural adaptation, as well as the detrimental effects of emotional neglect in childhood; these components should be further addressed in future studies.

Du and Zhang "*Analysis of the mediating effects of self-efficacy and self-control between physical activity and Internet addiction among Chinese college students*": it was demonstrated that physical activity not only has a direct negative correlation with Internet addiction but also influences through two indirect forms: the mediating role of self-control and the chain mediating role of self-efficacy and self-control.

Iraurgi et al.'s *"Adaptation to Spanish of the "Relational Needs Satisfaction Scale": Translation and psychometric testing"*: the authors validated the Spanish version of the RNSS and demonstrated that it is a valid and reliable measure of the intended construct.

Section 3 - Effects of physical exercise on health and sports performance

Fujino et al.'s *"Decreased step count prior to the first visit for MDD treatment: a retrospective, observational, longitudinal cohort study of continuously measured walking activity obtained from smartphones"*: it was found that a significant decrease in daily step count preceded the formal diagnosis of Major Depressive Disorder (MDD) by ∼2 weeks, followed by a gradual increase after diagnosis and presumed treatment. These findings suggest the utility of objective and continuous measures to identify the development of MDD before it impacts work productivity.

Sánchez Cabaco et al.'s *"Mediation effects of cognitive, physical, and motivational reserves on cognitive performance in older people"*: the importance of measuring cognitive reserve as a variable for diagnosing neurodegenerative diseases was demonstrated, but it is also essential to consider physical status and activity, as well as motivational aspects.

Wada et al.'s *"Exploring the effects of COVID-19 on motorcycle riding patterns and its importance"*: these authors observed that individuals who spent their leisure time riding motorcycles attributed greater importance to personal space and shared time with others. This suggests that such activity provided a means of practicing social distancing while sharing moments with peers, mitigating loneliness and isolation during the pandemic.

This Research Topic, through its diverse contributions, provides a comprehensive insight into the intersection of physical activity, social psychology, and mental health promotion.

The conclusions drawn from the studies highlight the importance of physical activity and social contact in various aspects of life, ranging from preventing mental disorders to improving social adaptability and overall wellbeing.

Author contributions

BR-L: Writing – original draft. JM-G: Writing – original draft. AG-P: Writing – original draft. ML: Writing – original draft. SL-G: Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 23 August 2022
DOI 10.3389/fpsyg.2022.992205

Check for updates

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Personality and Social Psychology, a section of the journal Frontiers in Psychology

RECEIVED 12 July 2022
ACCEPTED 01 August 2022
PUBLISHED 23 August 2022

CITATION
Iraurgi I, Gómez-Marroquín I, Erskine R, Mauriz A, Martínez-Rodríguez S, Gorbeña S and Žvelc G (2022) Adaptation to Spanish of the "Relational Needs Satisfaction Scale": Translation and psychometric testing. *Front. Psychol.* 13:992205. doi: 10.3389/fpsyg.2022.992205

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Adaptation to Spanish of the "Relational Needs Satisfaction Scale": Translation and psychometric testing

Ioseba Iraurgi[1]*, Ignacio Gómez-Marroquín[1], Richard Erskine[2], Amaia Mauriz[3], Silvia Martínez-Rodríguez[1], Susana Gorbeña[1] and Gregor Žvelc[4]

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This article aims to adapt to Spanish the Relational Needs Satisfaction Scale (RNSS) and to test the factor structure with a clinical and a non-clinical sample. A total of 459 individuals completed the RNSS, a measure of life satisfaction and of psychological wellbeing. Results showed that the translation was adequate. An exploratory and confirmatory factor analysis was conducted followed by the test of three models that confirmed the five-factor structure and the second-order global factor proposed in the original study, and in adaptations to other languages. The advantages and disadvantages of these models are discussed. Correlations of the RNSS with life satisfaction and psychological wellbeing measures were in the expected direction, providing evidence of convergent validity. The Spanish version of the RNSS is a valid and reliable measure of the construct it was intended to measure, though some improvements in item wording could be incorporated and tested (for instance, item 18 should be positively worded as the rest of the items in order to avoid the effect of negative wording).

KEYWORDS

Relational Needs Satisfaction Scale, test translation, psychometric adequacy, validity evidence, integrative psychological therapy (IPT)

Introduction

Optimal human functioning necessarily requires a relationship with others (Ryan and Deci, 2017). Relational needs have been strongly associated with improved health (vitality, self-determination, self-control, ...) and wellbeing (Maslow, 1987; Baumeister and Leary, 1995; Kasser and Ryan, 1999; La Guardia et al., 2000; Ryan and Deci, 2000) and despite differences in theoretical approaches, there is a remarkable convergence among scientists on the fundamental importance of being

connected to others (La Guardia and Patrick, 2008; Ryan and Deci, 2017).

Within the specific framework of integrative relational psychotherapy and transactional analysis, the relational needs model developed by Erskine (1996, 1997, 1998) is widely recognized (Pourová et al., 2020). This model emerged from a study of transference in psychotherapy and a qualitative investigation of the crucial factors in significant relationships conducted at the Institute for Integrative Psychotherapy in New York City in the early 1990s. However, relational needs are not only present in the context of psychotherapy; they are essential to a person's sense of wellbeing throughout the life cycle (Erskine, 2015). In this respect, relational needs are the component parts of a universal human desire for the relationship; they are the *needs unique to interpersonal contact* (Erskine, 2015, p. 46). Relational needs are not the basic needs of life, such as food, air, or proper temperature, but they are the essential elements that enhance the quality of life and a sense of self-in-relationship. When a relational need is not satisfied, the need becomes more intense and is phenomenologically experienced as longing, emptiness, nagging loneliness, or an intense urge often accompanied by nervousness (Erskine et al., 1999). The continued absence of satisfaction with relational needs may be manifested as frustration, aggression, or anger. When disruptions in the relationship are prolonged, the lack of need satisfaction is manifested as a loss of energy or hope and shows up in *script beliefs*, such as "*No one is there for me*" (Erskine et al., 1999, Erskine and Moursund, 2011). These script beliefs are the cognitive defenses when needs do not get a satisfying response from another person (Erskine, 1980).

Žvelc et al. (2020) have emphasized this need for the relationship as a primary human motivation and have substantiated their perspective on several child development researchers and writers (Fairbairn, 1952; Bowlby, 1969, 1973, 1980; Kohut, 1971; Ainsworth et al., 1978; Stern, 1985; Fairbairn, 1986/1941; Winnicot, 1986/1960; Hesse, 1999). Attachment systems motivate infants to seek proximity and communication with caregivers. Therefore, attachment has an important evolutionary function—to heighten the possibility of survival of the child. Additionally, attachment relationship is crucial for the healthy development of both the brain and interpersonal relationships (Schore, 1994, 2001, 2003; Siegel, 1999; Cozolino, 2002). The qualities of affect and rhythmic attunement, relational needs, and sustained gestures of attachment between child and parent that provide the regulation of a child's body sensations and affects are crucial for establishing a sense of safety, connection, and secure attachment (Erskine, 2021). In fact, attachment theory and research have underscored the importance of attachment and relational needs through the life cycle (Hazan and Shaver, 1987; Bartholomew and Horowitz, 1991; Hesse, 1999; Wallin, 2007).

The relational needs identified by Erskine and included in his model are the following (Erskine et al., 1999; Erskine, 2021): (1) *security* is the visceral experience of having our physical and emotional vulnerabilities protected. It involves the experience that our variety of needs and feelings are human and natural. Security is a sense of simultaneously being vulnerable and in harmony with another; (2) to *feel validated*, *affirmed*, and *significant* within a relationship requires the other person's validation of the significance and function of our intrapsychic processes of affect, fantasy, and meaning-making, and to validate that our emotions are a significant intrapsychic and interpersonal communication. It includes the need to have all of our relational needs affirmed and accepted as natural. This need is a relational request for the other person to be involved by providing a quality of interpersonal contact that validates the legitimacy of relational needs, the significance of affect, and the function of intrapsychic processes; (3) *acceptance by a stable*, *dependable*, and *protective other person* is an essential relational need. Each of us as children had the need to look up to and rely on our parents, elders, teachers, and mentors. We need to have significant others from whom we gain protection, encouragement, and information. The relational need for acceptance by a consistent, reliable, and dependable other person is the search for protection and guidance; (4) the *confirmation of personal experience* is also an essential relational need. The need to have experience confirmed is manifested through the desire to be in the presence of someone who is similar, who understands because he or she has had a similar experience, and whose shared experience is confirmed. It is the quest for mutuality, a sense of walking, together with a companion who is "like me," who has walked the same path in life. It is the need to have someone appreciate and value our experience because they phenomenologically know what that experience is like; (5) *self-definition is* the relational need to know and express one's own uniqueness and to receive acknowledgment and acceptance from the other. Self-definition is the communication of one's self-chosen identity through the expression of preferences, interests, and ideas without humiliation or rejection; (6) another essential relational need is *to have an impact on the other person*. Impact refers to having an influence that change the other in some desired way. An individual's sense of competency in a relationship emerges from agency and efficacy, attracting the other's attention and interest, influencing what may be of interest to the other person, and affecting a change in affect or behavior in the other; (7) the need to *have the other person initiate* refers to the impetus of another person's making interpersonal contact. It is the reaching out to another, in some way that acknowledges and validates their investment in the relationship; and (8) the need to *express love* is an important component of relationships. Love is often expressed through quiet gratitude, thankfulness, giving affection, or doing something for the other person. The relational need to express love, whether it be from children to parents, sibling or teacher, or from a client to a therapist, is an important component in maintaining relationships. When

the expression of love is stymied, the expression of self-in-relationship is thwarted.

Žvelc and Jovanoska (2016, 2017) and Žvelc et al. (2020) developed a new instrument for measuring the satisfaction of relational needs in the general population (RNSS). The final version is comprised of 20 items rated on a five-point Likert scale from agree to disagree. The scale yields five subscales and a total score of satisfaction of relational needs. The first four subscales (support and protection, have an impact, shared experience, and initiative from the others) reflect the relational needs described by Erskine. According to Žvelc et al. (2020), the fifth scale reflected the other four dimensions of the model as an overall dimension and was named need for authenticity. The instrument has been validated in Slovenian (Žvelc et al., 2020), Czech (Pourová et al., 2020), and Turkish (Toksoy et al., 2020) and showed good psychometric properties and the confirmation of the factorial structure and the hierarchical model.

Given the lack of instruments to measure relational needs in Spanish, the purpose of this article is to adapt the Relational Needs Satisfaction Scale (RNSS) using both a clinical and non-clinical sample and to analyze its psychometric properties. It is expected that the Spanish version of the RNSS presents adequate psychometric properties in terms of reliability and construct and discriminant validity, thus offering new evidence of the validity of the instrument.

Materials and methods

Design

It is an instrumental cross-sectional study to translate and adapt a psychometric instrument to Spanish following Sousa and Rojjanasrirat (2011) recommendations. The study was conducted between September 2018 and December 2019 in two different phases. In the first phase (Phase 1), which was conducted between September and December 2018, the process of translating and adapting the Relational Needs Satisfaction Scale from English to Spanish was undertaken. Whereas in the second phase (Phase 2), carried out between January 2019 and December 2019, the field study for the psychometric validation of the instrument was undertaken. **Figure 1** shows the flow chart of the methodological process.

Procedure

Phase 1.- translation of the RNSS (pilot study)

Acquadro et al. (2004) recommendations and methodology of translation were used. The first step consisted of the translation of the original version (in English) to the target

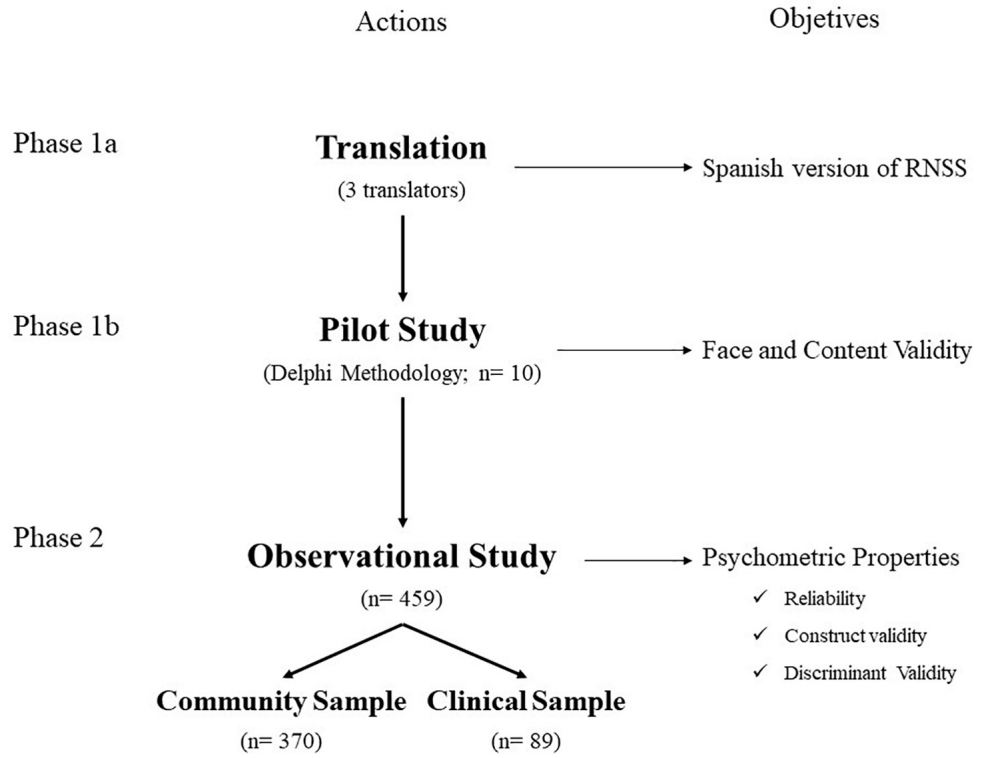

FIGURE 1
Flowchart of the methodological process.

version (in Spanish). In order to do this, three translators that had knowledge of both languages took part in the process. Two of them were native Spanish and one of them was native Irish. They translated the test independently. One was selected as the gold standard (T0), an expert on psychotherapy with formal education in integrative psychotherapy. The other two translators have formal graduate education in psychology (T1) and in international relationships (T2). Inter-rater agreement analysis was conducted taking as a reference the gold standard. Agreement and discrepancy with the standard were calculated utilizing inter-rater reliability with kappa coefficients (κ).

Once a Spanish version was produced, a pilot study with 10 volunteers was conducted following a Delphi methodology (Trevelyan and Robinson, 2015). The participants answered three questions to analyze the face and content validity. Using a 10-point response format, individuals were asked if (1) the items were worded in such a way that they were easily (0) or hardly (10) understood, (2) they were related (0) or they did not have relation at all (10) with the topic of relationships, and (3) if they felt represented (0) or not at all (10) with the proposed statements. The main aim of these questions was to be able to count with an indicator that could give information regarding the face and content validity of the RNSS.

Phase 2.- psychometric properties

To study the psychometric features of the translated scale, a cross-sectional observational design was used with a sample of volunteers that answered an informed consent that was included in the RNSS questionnaire.

Sample and procedure

Four hundred fifty-nine participants were recruited. One sub-sample was a clinical group of 89 people being treated for emotional distress in a mental health center; the other, 370 participants from the community with no history of psychological problems. No statistically significant differences were found with respect to the socio-demographic characteristics of the two samples (age: $F = 2.65$, $p = 0.104$; sex: $\chi^2 = 0.87$, $p = 0.207$; employment status: $\chi^2 = 2.23$, $p = 0.844$). The mean age of the participants was 39.36 years (SD = 14.81) with ages ranging from 18 to 65 years; there was an equal distribution of men (51.2%) and women (48.8%), and the majority were employed (91%).

All participants were informed of the objectives of the study and were given the chance to clarify any doubts. Inclusion criteria were: being 18 years or older, volunteer participation, and absence of incapacitating conditions that could affect response patterns (cognitive impairment for reading and comprehension, severe mental health disorder, or substance abuse). The field study of the community sample was conducted by four trained persons with a background in psychology. Access to the sample was facilitated by the network of contacts with associations and institutions collaborating with the research team. The clinical sample was assessed by one of the researchers who carry out his clinical practice in a community mental health service. In this respect, in both cases, it is a non-probability opportunity sample. The study was approved by the research ethics committee and by those responsible for the organizations where their samples were obtained. Verbal consent was given by all participants and the anonymity and confidential treatment of the information provided were guaranteed.

Instruments

Relational Needs Satisfaction Scale

Žvelc et al. (2020) the test has a total of 20 items and measures five conceptual dimensions of Erskine's (2015) relational needs model allowing for five scalar scores (see section "Introduction"). Each of these scales consists of four items stated to be answered on a five-point Likert scale, from one (1) "*never true*" to five (5) "*always true*." The original study obtained high reliability for the total scale ($\alpha = 0.90$), as well as for the five dimensions (internal consistency values between 0.73 and 0.85). Convergent validity was also calculated with associations in the expected direction with life satisfaction and wellbeing.

Satisfaction with life scale

Diener et al. (1985) adapted by Vázquez et al. (2013) to Spanish. It consists of five items with a seven-point response format, from "*strongly agree*" to "*strongly disagree*." It is a sound and widely used measure, and the internal consistency reported in the original study was high ($\alpha = 0.87$), as well as the values reported in Spanish adaptation ($\alpha = 0.88$). In our study, Cronbach's alpha was 0.81.

Scales of psychological wellbeing

Ryff (1989) developed this instrument. In this study, the version proposed by Van Dierendonck (2004) and adapted to Spanish by Díaz et al. (2006) was used. The SPWB consists of 31 items rated on a six-point Likert scale, ranging from one (*totally disagree*) to six (*totally agree*), and allows the assessment of six dimensions of eudaimonic wellbeing. For the purposes of our study, we used a global measure of wellbeing based on the contribution of all items. The observed reliability of this global indicator was 0.91 for the present study.

Statistical analysis

For the analysis of the RNSS items, the mean (M), standard deviation (SD), skewness (Sk), and the correlation coefficient between the items and the rest of the scale (r) were calculated, as well as the value of Cronbach's alpha coefficient (α) if the item was removed.

The internal consistency of the total RNSS and its five dimensions was calculated for the total number of participants and for each of the samples (clinical vs. non-clinical), and we use Feldt's test (Feldt, 1980) to test the hypothesis that the Cronbach's alpha reliability coefficient is the same for two tests administered to the same sample. Based on the hypothesis that relational needs in emotionally disturbed people will be less satisfied than in non-emotionally disturbed people, we tested the differences in means between the two groups (clinical vs. non-clinical) using the ANOVA test.

To test the factor structure of the RNSS (Lorenzo-Seva and Ferrando, 2006), we checked the adequacy of the correlation matrix to ensure its factorization based on the Kaiser–Meyer–Olkin test and Bartlett's sphericity test. Hull method (PA) (Lorenzo-Seva et al., 2011) and minimum average partial method (MAP) (Velicer, 1976) were carried out as extraction criteria for the advisable number of factors according to the configuration of the correlation matrix. Finally, the multivariate normality was analyzed with the Mardia (1970) test.

Subsequently, a confirmatory factor analysis (CFA) with covariance structural techniques using EQS (Bentler, 2004) was conducted. Maximum likelihood robust estimation was used to estimate the parameters. The chi-squared test (χ^2) was used to evaluate the goodness of fit of the corresponding model and indicated that the probability that the variation between the sampling variance, covariance matrix, and the matrix resulting from the hypothesized model was random. In the event of non-compliance with the multivariate normality, estimations were calculated applying robust methods (Satorra and Bentler, 1990; Satorra, 2002). Given that the chi-square is sensitive to variations in sample size (Schermelleh-Engel et al., 2003), additional measurements of the goodness of fit of the model were used (Hu and Bentler, 1999), such as standardized root mean square residual (SRMR) and the root mean square error of approximation (RMSEA) and 90% confidence interval of RMSEA, which considers values <0.05 to be adequate and those <0.08 to be acceptable; the goodness-of-fit index (GFI), Bentler–Bonnet non-normal fit index (BB-NNFI), and comparative fit index (IFI), which considers values >0.90 to be adequate.

Three structure models were tested: a model of five correlated factors (F5C), a hierarchical model of five factors subsumed in a general second-order factor (F5F1), and a bi-factor model (Bi-F). The bi-factor model is a type of second-order confirmatory factor analysis that assumes the existence of a general factor that explains the covariance of all observed measures (Brown, 2014) and simultaneously presents several first-order factors that mediate and explain a portion of the same items (Chen et al., 2006). Thus, it is possible to specify the direct effects of the first-order factors and the general (second-order) factor, without necessarily being correlated. It is appropriate for measurement scales that provide an interpretable total score but have subdomains that have substantive value for research (Brown, 2014).

Finally, to test the convergent validity of the RNSS, we assessed the association of the RNSS total score and subscales with two reference instruments (life satisfaction, and Ryff's scales of psychological wellbeing). Since some of the variables were non-normally distributed, we use the Spearman correlation coefficient.

Results

Phase 1. translation–back translation

Both translations from English to Spanish (T1 vs. T2) agreed on 18 items of the scale giving a level of agreement of 90%. Translator 1 (T1) coincided in 18 out of 20 items with the gold standard, and Translator 2 (T2) in 20. The degree of agreement in the inter-rater reliability, based on the Kappa coefficient, was high ($\kappa = 0.87$).

Table 1 presents the judgments of 10 volunteers who assessed the 20 items in terms of ease of understanding, relevance to relational needs, and appropriateness. In general, the scores are low, indicating that the items were easy to understand except for item 18, negatively worded. No item reflected an average score greater than five out of 10, not even in the maximum scores. The items that reflected a higher score are 2, 10, 16, and 18, with the highest mean being that of item 18 ($M = 2.4$) in the assessment of difficulty in understanding the item.

Phase 2. psychometric characteristic

Table 2 presents the descriptive data of the 20 items that form the RNSS in the total sample. The percentage of individuals choosing each option, the mean, standard deviation, and skewness as statistics of central tendency and position are included. The table also includes the items reliability data, both for the subscales and for the total score. Finally, the last two columns present the results of the exploratory factor analysis, giving the communality values (h^2) and factor loadings (λ) for each item.

As can be seen in the table, the mean of the total scale is 3.54, in a range from 1 to 5 points. All the items, except items 06, 07, and 15, show a smooth negative asymmetry which means that people tended to answer with high scores. There is one item where the asymmetry is presented in an important way (out of rank: Sk > 1.25), this happens in item 13 with an asymmetry of −1.29. In general, it is possible to see the ceiling effect in two items (12 and 16) of the authenticity subscale, and in two items (04 and 13) in protection. Thus, in these two dimensions, there are items that more than 40% of the participants responded to option 5. This effect does not happen in the other dimensions of

TABLE 1 Assessment of the understanding and adequacy of the items of the RNSS (n = 10).

Item	Wording	Easily (0) or Hardly (10) understood				Related (0) or not (10) with relations with people				Represented (0) or not (10) with the proposed statements			
		Min	Max	M	SD	Min	Max	M	SD	Min	Max	M	SD
01	My social circle consists of . . .	0	3	0.8	0.4	0	3	0.8	0.4	0	2	0.9	0.2
02	I hardly have to hide . . .	0	4	1.2	0.8	0	3	1.1	0.8	0	4	1.8	0.7
03	I have a strong, stable and . . .	0	2	0.7	0.3	0	1	0.2	0.3	0	3	0.9	0.6
04	I know a capable individual . . .	0	2	0.5	0.2	0	1	0.4	0.4	0	2	0.8	0.5
05	I know people who experience . . .	0	2	0.2	0.2	0	2	0.7	0.3	0	2	1.0	0.6
06	Others often take my advice . . .	0	3	0.9	0.3	0	2	1.1	0.4	0	3	1.2	0.8
07	Other people often help me . . .	0	2	0.7	0.3	0	2	0.4	0.4	0	2	0.4	0.6
08	I know people with a world- . . .	0	3	1.0	0.4	0	3	0.9	0.3	0	3	1.1	0.6
09	Other people sometimes . . .	0	2	0.8	0.2	0	2	0.8	0.4	0	2	0.9	0.6
10	People close to me would . . .	1	3	1.2	0.5	0	2	0.9	0.3	0	2	0.6	0.4
11	I feel free to show my . . .	0	2	0.9	0.4	0	1	0.3	0.2	0	1	0.5	0.3
12	I do not have to pretend . . .	1	3	1.1	0.6	0	2	0.6	0.5	0	2	0.9	0.4
13	I have at least one person in . . .	0	0	0.0	0.0	0	0	0.0	0.0	0	0	0.0	0.0
14	There are people in my life . . .	0	0	0.0	0.0	0	1	0.2	0.2	0	2	0.4	0.5
15	I feel that I have an influence . . .	0	0	0.0	0.0	0	1	0.3	0.3	0	0	0.0	0.0
16	I can show my true self . . .	0	3	1.2	0.5	0	2	0.9	0.5	0	2	0.9	0.5
17	In times of trouble, I have . . .	0	3	1.1	0.6	0	1	0.4	0.4	0	1	0.5	0.6
18*	No-one ever prepares.	2	6	2.4	0.9	2	4	1.7	1.2	2	4	2.1	1.2
19	I have noticed that other . . .	0	2	0.9	0.6	0	2	0.7	0.7	0	3	1.1	0.5
20	Other people often ask about . . .	0	1	0.3	0.2	0	1	0.4	0.2	0	2	0.8	0.4

Min, minimum; Max, maximum; M, mean; SD, standard deviation.
*, reverse items.

the RNSS. No floor effects (low percentages in more than 40% of the answers) were observed.

The reliability of the total of items of the RNSS was high (α = 0.875), and the withdrawal of any of its items would not allow obtaining a notorious increase in its internal consistency. Two subscales showed high alpha values (protection α = 0.82 and having impact α = 0.75), two other subscales had acceptable values (authenticity α = 0.70 and shared experience α = 0.72), and finally, the initiative from the other subscale had a low internal consistency value (α = 0.48). Note that the removal of item 18 would increase the reliability of the initiative dimension to 0.63. In parallel, the communalities are low ($h^2 < 0.20$) in three items (02, 09, and 18), although only item 18 shows an insufficient factor loading ($\lambda < 0.40$).

Table 3 presents the means and standard deviations for the five subscales and the total scale, for the two samples, along with the reliability values of the scales in each sub-sample. The analysis of variance shows statistically significant differences for all contrasts except for the dimensions "initiative from others" ($F = 0.92$; $p = 0.323$) and "having an Impact" ($F = 2.33$; $p = 0.127$), with higher mean values in the community sample, indicating a higher satisfaction of relational needs than the clinical sample. However, the effect sizes achieved are moderate to low ($d < 0.40$).

The internal consistency of the total scale in both samples is the same (α = 0.87), and equivalent to the rest except in the case of the authenticity subscale where it is significantly higher (Feldt's test = 0.68, $p = 0.008$) in the community sample (α = 0.72) than in the clinical sample (α = 0.59). Regarding the association between the subscales of the RNSS (right section of Table 3), positive and statistically significant correlations ($p < 0.01$) are observed between all dimensions with values

TABLE 2 Descriptive and psychometric characteristics of RNSS (n = 459).

		Percentage distribution and descriptive statistics								Reliability				EFA	
										Subscales		Total Scale			
Item	Wording	1	2	3	4	5	M	SD	Sk	r	α	r	α	h^2	λ
02	I hardly have to hide . . .	8.3	19.8	16.8	33.3	21.8	3.41	1.25	−0.38	0.380	0.708	0.270	0.873	0.196	0.442
11	I feel free to show my . . .	2.4	10.7	30.7	32.5	23.7	3.64	1.03	−0.36	0.522	0.616	0.576	0.866	0.457	0.676
12	I do not have to pretend . . .	8.9	6.8	12.9	31.2	40.3	3.87	1.26	−1.03	0.552	0.590	0.503	0.868	0.473	0.688
16	I can show my true self . . .	1.1	6.3	17.4	33.1	42.0	4.09	0.98	−0.88	0.516	0.624	0.627	0.864	0.444	0.666
	Authenticity						3.75	0.82	−0.35		0.699				
03	I have a strong, stable . . .	2.8	7.6	17.4	32.2	39.9	3.99	1.06	−0.92	0.640	0.775	0.466	0.869	0.523	0.723
04	I know a capable individ. . . .	0.7	6.3	12.0	32.9	48.1	4.22	0.93	−1.10	0.596	0.794	0.618	0.865	0.453	0.673
13	I have at least one person . . .	1.1	6.5	10.9	26.6	54.9	4.28	0.97	−1.29	0.705	0.746	0.548	0.867	0.667	0.816
17	In times of trouble. I . . .	4.4	9.8	24.6	29.6	31.6	3.74	1.13	−0.61	0.640	0.777	0.525	0.867	0.518	0.720
	Support and Protection						4.05	0.82	−0.88		0.820				
06	Others often take my . . .	9.4	33.6	32.5	18.7	5.9	2.78	1.04	0.26	0.409	0.765	0.276	0.876	0.215	0.464
15	I feel that I have an influence . . .	8.7	29.2	36.5	20.9	4.6	2.83	1.00	0.09	0.577	0.668	0.429	0.871	0.466	0.683
19	I have noticed that other . . .	3.5	22.4	38.8	29.8	5.4	3.11	0.93	−0.08	0.630	0.641	0.523	0.863	0.624	0.790
20	Other people often ask.	2.6	18.3	40.1	31.2	7.8	3.23	0.92	−0.08	0.568	0.675	0.497	0.868	0.492	0.702
	Having an Impact						2.99	0.73	0.01		0.747				
01	My social circle consists . . .	5.4	18.3	26.1	38.8	11.3	3.32	1.06	−0.37	0.446	0.699	0.443	0.870	0.285	0.534
05	I know people who . . .	2.4	14.8	34.6	35.5	16.5	3.41	0.96	−0.22	0.385	0.727	0.537	0.867	0.207	0.455
08	I know people with a . . .	2.6	14.6	292	36.2	17.4	3.51	1.02	−0.32	0.602	0.601	0.626	0.864	0.574	0.758
14	There are people in my . . .	0.9	9.6	27.5	36.8	25.3	3.76	0.96	−0.38	0.619	0.575	0.638	0.864	0.617	0.785
	Shared Experience						3.53	0.79	−0.26		0.721				
07	Other people often help . . .	5.4	27.0	34.4	25.7	7.4	3.03	1.02	0.05	0.373	0.312	0.454	0.870	0.453	0.653
09	Other people sometimes . . .	1.3	10.5	29.0	40.1	19.2	3.65	0.94	−0.37	0.312	0.378	0.529	0.867	0.192	0.434
10	People close to me would . . .	2.6	19.8	35.5	31.8	10.2	3.27	0.97	−0.07	0.452	0.236	0.519	0.868	0.581	0.756
18*	No-one ever prepares . . .	2.2	8.7	24.6	33.1	31.4	3.83	1.03	−0.59	0.028	0.631	0.049	0.883	0.041	0.037
	Initiative from Other						3.44	0.62	0.11		0.480				
	RNSS Total Score						3.54	0.56	−0.43				0.875		

M, mean; SD, standard deviation; Sk, skewness; r, correlation coefficient of the item with the rest of the scale/subscale; α, Cronbach's alpha: value of the reliability if the items is removed; EFA, exploratory factor analysis; h^2, communality; λ, factorial weights. *, reverse item.

ranging from r = 0.25 (protection with having an impact) to r = 0.55 (shared experience with authenticity). The correlations of each dimension with the total scale are high in all cases ($r \geq 0.66$).

Correlations with life satisfaction and psychological wellbeing were positive and statistically significant (authenticity: 0.17 and 0.40, protection: 0.22 and 0.26, having an impact: 0.10 and 0.28, shared experience: 0.17 and 0.36, initiative from other: 0.09 and 0.24, total score: 0.20 and 0.42), although the correlation values have been moderate.

To assess whether the data could be subjected to factor analysis, the correlation matrix was tested. The Kaiser–Meyer–Olkin (KMO = 0.916) and Bartlett sphericity tests [$\chi^2_{(190)} = 3211.2$; $p < 0.001$] showed that the items of the RNSS have intercorrelations and, therefore, the matrix is susceptible to be factored. Likewise, the Velicer (MAP) and Hull method suggest that a major factor should be retained. The exploration of the possible resulting factors by means of an exploratory strategy through the FACTOR program offers a solution of four factors with eigenvalues superior to 1. However, the first factor offers an eigenvalue of 6.83, compared with an eigenvalue of 1.57 for the second factor. Since the first factor is more than three times higher than the second factor, the presence of a major factor is assumed and the residual factors are disregarded (Gorsuch, 1983).

The result of the factorial exploration of the correlation matrix suggests the presence of the main factor in our data sample. For this reason, a structure model of RNSS has been tested, assuming that the items of the instrument allow for differentiating five dimensions and that these, in turn, conform to a second-order main latent factor referred to as relational needs. Alternatively, the existence of a bi-factor model has also been tested where RNSS items saturate simultaneously on a general factor and its five corresponding dimensions. A five-factor correlated model has also been tested. To test this model, the correlation matrix was subjected to a confirmatory factorial analysis through the EQS program. Since the correlation matrix presents multivariate asymmetry (Mardia index = 45.12), the maximum likelihood robust method was used to estimate the models. These models have been tested

TABLE 3 Descriptive statistics and reliability for each sub-sample, intergroup contrast, and correlations between RNSS scales for total sample (n = 459).

		Community group (n = 370)			Clinic group (n = 89)			ANOVA and effect sizes				Correlation for total sample				
		M	SD	Alpha	M	SD	Alpha	F	p	η^2	d	1	2	3	4	5
1	Authenticity	3.81	0.81	0.718	3.48	0.83	0.590	11.65	<0.001	0.026	0.33					
2	Support and Protection	4.10	0.81	0.826	3.86	0.88	0.791	5.66	0.018	0.012	0.22	0.45				
3	Having an Impact	3.01	0.71	0.750	2.38	0.82	0.734	2.33	0.127	0.005	0.14	0.35	0.25			
4	Shared Experience	3.55	0.72	0.721	3.28	0.79	0.698	9.54	0.002	0.021	0.29	0.55	0.54	0.52		
5	Initiative from Other	3.46	0.60	0.457	3.38	0.69	0.537	0.92	0.323	0.002	0.09	0.45	0.47	0.36	0.52	
6	Total Score	3.59	0.54	0.874	3.38	0.62	0.878	8.35	0.005	0.021	0.29	0.76	0.74	0.65	0.84	0.73

M, mean; SD, standard deviation; α, Cronbach's alpha: value of the reliability; F, ANOVA test; p: probability value; η^2, partial eta square; d, Cohen's d coefficient.

TABLE 4 Confirmatory factor analysis of RNSS for the total sample. Fit indices are estimated using the robust method.

Sample	Model	χ^2	df	χ^2/df	AIC	GFI	BB-NNFI	CFI	SRMR	RMSEA	(90% CI)		Rho
Total (n = 459)	F5C	405.41	160	2.53	85.42	0.901	0.900	0.907	0.058	0.058	(0.051	0.065)	0.900
	F5F1	429.63	165	2.60	99.63	0.897	0.885	0.900	0.069	0.059	(0.052	0.066)	0.900
	Bi-F	333.15	150	2.22	33.15	0.918	0.912	0.931	0.053	0.052	(0.044	0.059)	0.909

Model: F5C: five-factor correlated; F5F1: hierarchical model (SOFCA): Bi-F: Bi-factor model. Method: NDT: normal distribution theory; Robust: robust method.
Fit Indices, χ^2: Chi-square; df, degree of freedom; AIC, Akaike's information criterion; GFI, goodness fit index; BB-NNFI, bentler–bonnet non-normed fit index; CFI, comparative fit index; SRMR, standardized root mean square; RMSEA, root mean square error of approximation; CI, confidence interval; Rho, reliability coefficient.

for the total sample (n = 459), and the results are shown in Table 4.

The three models show adequate fit indices, but the model with the best fit is the bi-factor model [$\chi^2_{(150)}$ = 333.15; p < 0.001; GFI = 0.92, BB-NNFI = 0.91, CFI = 0.93, RMSEA = 0.052, 90% IC = 0.044 to 0.059] over the other two alternative models. The graphical representation and factor loadings of the bi-factor model for the total sample are shown in Figure 2, and the SOCFA model in Figure 3.

In general, the items tend to have higher loadings on the general factor, with only three items having low loadings of less than 0.35 (λ_{02_1} = 0.24, λ_{06_1} = 0.27, and λ_{18_1} = 0.06). The items that present a lower saturation in the general factor, present a higher weight in the dimensional factor [item 02 in "authenticity" (λ_{02_2} = 0.46), and item 06 in "having an impact" (λ_{06_3} = 0.37)], except for item 18 which presents low saturations in both the general factor (λ_{18_1} = 0.06) and the dimensional factor (λ_{18_6} = −0.04). Item 9 does not contribute to the dimension "initiative from other" (λ_{09_6} = −0.01), but showed an acceptable load (λ_{09_1} = 0.59) in the general factor.

The solution of the hierarchical or SOCFA model (Figure 3) shows factor loadings above 0.40 for all items, except for item 18 with loading of almost zero. Factor saturations on the second-order factor are above 0.70. These results are very similar to those obtained in the three international studies previously carried out (Pourová et al., 2020; Toksoy et al., 2020; Žvelc et al., 2020).

Discussion

The main objective of this study was to adapt to Spanish a scale that allows the measurement of relational needs for subsequent use in clinical practice contexts and in research with non-clinical populations. The observed results allow us to conclude that the Spanish adaptation of the RNSS offers adequate characteristics of language adaptation and measurement.

Inter-rater agreement of the translated version was appropriate. Likewise, the assessment made by 10 people of the characteristics of the item statements allows us to accept that they are easy to understand, that the items are related to the construct they intend to measure, and that the items are in the repertoire of interpersonal relationships (see Supplementary Table 1 for the final version of the Spanish scale). However, in the pilot study, it was already possible to identify some items that showed a differential behavior. Of these, item 18 is the item with the greatest number of problems in the psychometric adequacy of the scale. Nevertheless, we believe that the results obtained in the pilot study provide evidence for the face and content validity of the RNSS and that the translation is appropriate.

In general, the metric behavior of the items is acceptable. Mostly negative asymmetries are observed, indicating a tendency on the part of the participants to report higher relational satisfaction scores. This effect is more marked in the

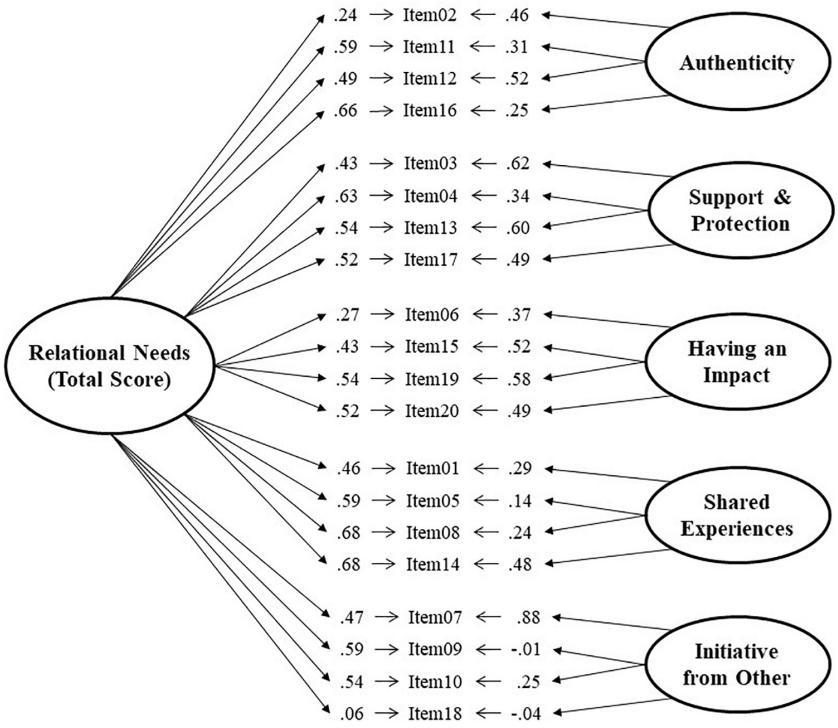

FIGURE 2
Bi-factor model of RNSS.

items belonging to the "protection" dimension (items 04 and 13), but there are no outliers in any of the remaining items. In this respect, item response behavior follows a pattern similar to that observed in other instruments used in psychological assessment (Holgado-Tello, 2015).

With respect to the internal consistency of the items, item 18, integrated into the dimension of "initiative from others," performed poorly. This item is the only one stated negatively and, as mentioned previously, it was one of the items that presented the greatest difficulties of comprehension. It is very likely that its different wording produces a response bias that could perhaps be corrected by changing its wording to positive.

Independently of the effect observed in item 18, the internal consistency shown for the total scale was high ($\alpha = 0.87$), very similar to that obtained in the original study (Slovenia, $\alpha = 0.90$), and in the two countries that adapted it to their language (the Czechia, $\alpha = 0.90$; and Turkey, $\alpha = 0.83$). However, if we look at the reliability observed in the dimensions, we see that performance is lower in the present study than in the Slovenian or Czech studies (Pourová et al., 2020; Žvelc et al., 2020), and more similar to the results obtained in the Turkish study (Toksoy et al., 2020).

In our study, the internal consistency observed in the community and clinical sample was equivalent except for the authenticity dimension. It has also been observed that, with the exception of the dimensions initiative from others and having an impact, the clinical sample had a statistically significant lower perception of satisfaction of needs in their relationships. This result allows us to accept that the RNSS shows evidence of discriminant validity.

Another important aim of our study was to confirm the factor structure of the RNSS. We have found empirical support that allows us to accept both the hierarchical structure of five factors subsumed in an overall factor proposed in the original study (Žvelc et al., 2020) and in the two adaptation studies (Pourová et al., 2020; Toksoy et al., 2020), as well as the proposed bi-factor model. Of the two, we favor the bi-factor (Bi-F) model based on the following criteria. Several authors (Reise et al., 2010, 2013; Chen et al., 2013) have summarized the advantages of the Bi-F model over second-order confirmatory factor analysis (SOCFA). The main advantage is that the Bi-F analysis allows to directly observe to what extent an item or scale (the observed variable) reflects a common target construct (i.e., a general factor) and, simultaneously, to what extent it may reflect a (domain-specific) sub-dimension. Consequently, the Bi-F model allows for the retention of a single common latent factor but also controls for variance arising due to additional common factors.

A second advantage of the Bi-F model is that in the SOCFA model it is not possible to observe direct relationships between the observed variables and the general factor, but rather an "indirect effect" or a "mediated relationship" through the first-order factors. Therefore, to estimate the variance attributable to the general factor, the loading of the observed

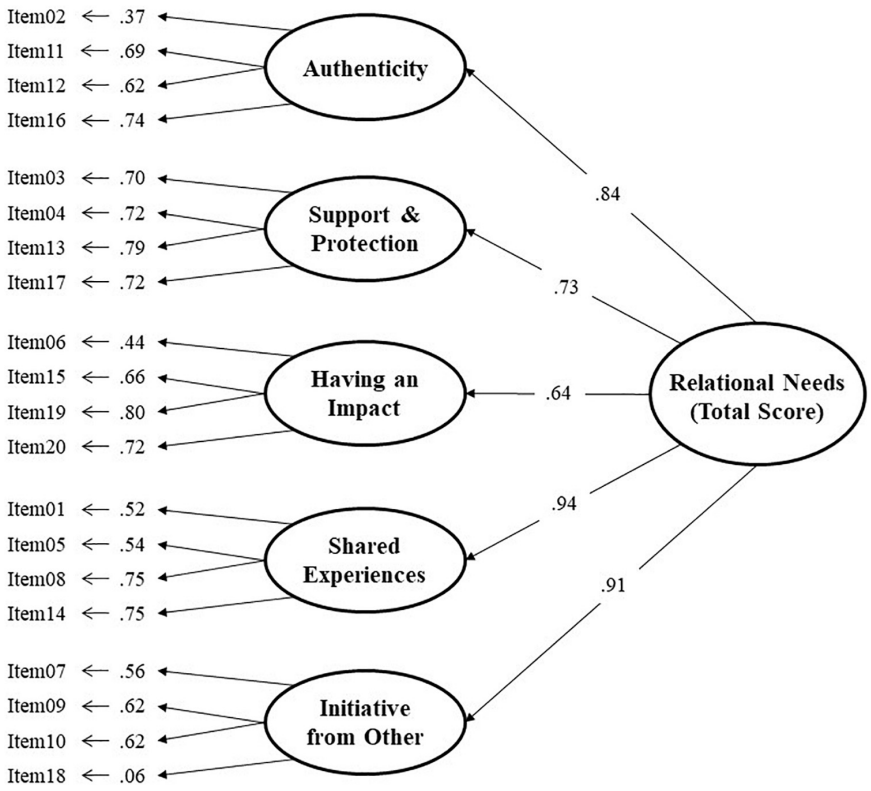

FIGURE 3
Hierarchical model of RNSS.

variable on the domain-specific factor must be multiplied by the loading of the domain-specific factor on the general factor (Chen et al., 2006, 2013). In contrast, the Bi-F model provides information on all factor loadings and makes it possible to identify whether a domain-specific factor uniquely contributes to the prediction of external criteria (Chen et al., 2006, 2013). Given that in a Bi-F model the general and domain-specific factors are orthogonal, even a simple inspection of the item loadings on the second- and first-order factors is informative.

Since the SOCFA model is nested in the Bi-F model, no such restrictions are present. The latter can be used as a base model to compare model fit as the model becomes more constrained, which is a third advantage of the Bi-F model over SOCFA (Brown, 2014). For example, in a SOCFA model, correlations between first-order factors are assumed to occur because they have a common cause (i.e., the overall factor). Therefore, the observation of low loadings on a domain-specific factor and high loadings of the specific factors on a general factor may suggest that these variables are best explained by a general factor and do not constitute a domain-specific factor. Thus, if the items mainly reflect the general factor and have low loadings on the first-order factors, the sub-scales make little sense.

Our results with the SOCFA/hierarchical model are very similar to those obtained in the previous studies (Pourová et al., 2020; Toksoy et al., 2020; Žvelc et al., 2020) and, as the researchers have concluded, the five-dimensional model that would represent Erskine's theory and the option of a general factor that would allude to the concept of relational needs would be satisfied. However, the Bi-factor model offers other possible conclusions. The data collected in the Spanish sample preferably offered the option of a general factor. The Velicer analysis and the solution of the Bi-factor model seem to favor this option. The factor loadings are of larger effect size than in the specific dimensions, although this does not rule out the contribution of the items to the latent factors representing the dimensions explored. Further work is needed to confirm this solution, and one possibility would be to seek an integration of all the data obtained in the various studies that have examined the evidence for the validity of the RNSS.

In sum, the adaptation to Spanish of the RNSS has shown an appropriate inter-rater agreement in the translation of the Spanish statements, as well as in the functionality of the item comprehension and the use of the relational needs valuation. In other words, the scale shows face and content validity. Besides, the results demonstrated that the RNSS has an adequate accuracy of measurement with sufficiently high coefficients and appropriate construct validity that is expressed through

a suitable index of adjustment on the confirmatory factorial analysis. Therefore, this study gathers evidence to consider the translated RNSS as an appropriate instrument for the measurement of the mentioned construct. Nevertheless, it is necessary to adjust some aspects of the formulation of an item (number 18) and the execution of new studies with more controlled designs to demonstrate other evidence of validity. It will be advisable to check the invariance of the dimensional structure of the RNSS in different populations (clinical vs. community samples) or in different cultures and relational contexts (individualistic vs. Collectivistic cultures). Furthermore, we could also test the discriminative power of the RNSS in these conditions and the predictive validity as it regards functionality, health, and wellbeing. Finally, the instrument has been developed after Erskine's theory of relational needs, and thus it can be a useful tool within the framework of integrative psychotherapy, both for diagnostic and assessment purposes.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethical Committee of the University of Deusto (ETK-19/19-20). The patients/participants provided their written informed consent to participate in this study.

Author contributions

II designed the study, articulated the methodology and results in sections of the manuscript, conducted the data analysis, and wrote the draft manuscript. IG-M, AM, and SM-R played a role in item development and data collection. RE supervised the research and contributed to the writing of the manuscript. SG was responsible for writing the manuscript and contributed to the discussion of the results. GŽ contributed to the design of the study and the discussion. All authors reviewed and approved the final version of the manuscript.

Acknowledgments

We thank all the participants in this study.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.992205/full#supplementary-material

References

Acquadro, C., Conway, K., Giroudet, C., and Mear, I. (2004). *Linguistic Validation Manual for Patient-Reported Outcomes (PRO) Instruments*. Lyon: MAPI Research Institute.

Ainsworth, M. D. S., Blehar, M. C., Waters, E., and Wall, S. (1978). *Patterns of Attachment: A Psychological Study of the Strange Situation*. Mahwah, NJ: Lawrence Erlbaum.

Bartholomew, K., and Horowitz, L. M. (1991). Attachment styles among young adults: A test of a four-category model. *J. Pers. Soc. Psychol.* 61, 226–244. doi: 10.1037//0022-3514.61.2.226

Baumeister, R. F., and Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychol. Bull.* 117, 497–529. doi: 10.1037/0033-2909.117.3.497

Bentler, P. M. (2004). *EQS 6 Structural Equations Program Manual*. Encino, CA: Multivariate Software, Inc.

Bowlby, J. (1969). *Attachment. Volume I of Attachment and loss*. New York, NY: Basic Books.

Bowlby, J. (1973). *Separation: Anxiety and Anger. Volume II of Attachment and Loss*. New York, NY: Basic Books.

Bowlby, J. (1980). *Loss: Sadness and Depression. Volume III of Attachment and Loss*. New York, NY: Basic Books.

Brown, T. A. (2014). *Confirmatory Factor Analysis for Applied Research*, Vol. 2d ed. New York, NY: Guilford Publications.

Chen, F. F., Jing, Y., Hayes, A., and Lee, J. M. (2013). Two concepts or two approaches? A bifactor analysis of psychological and subjective well-being. *J. Happiness Stud.* 14, 1033–1068.

Chen, F. F., West, S. G., and Sousa, K. H. (2006). A comparison of bifactor and second-order models of quality of life. *Multivar. Behav. Res.* 41, 189–225. doi: 10.1207/s15327906mbr4102_5

Cozolino, L. (2002). *The Neuroscience of Psychotherapy. Building and Rebuilding the Human Brain*. New York, NY: W.W. Norton & Company.

Díaz, D., Rodríguez-Carvajal, R., Blanco, A., Moreno-Jiménez, B., Gallardo, I., Valle, C., et al. (2006). Adaptación española de las escalas de bienestar psicológico de Ryff [Spanish adaptation of the psychocological well-being scales]. *Psicothema* 18, 572–577.

Diener, E., Emmons, R., Larsen, R. J., and Griffin, S. (1985). The satisfaction with life scale. *J. Pers. Assess.* 49, 71–75. doi: 10.1207/s15327752jpa4901_13

Erskine, R. G. (1980). Script cure: Behavioral, intrapsychic and physiological. *Trans. Anal. J.* 10, 102–106. doi: 10.1177/036215378001000205

Erskine, R. G. (1996). "A therapeutic relationship," in *First Congress of the World Council for Psychotherapy*, (Vienna).

Erskine, R. G. (1997). "The psychotherapy relationship," in *7th. Annual Conference of the European Association for Psychotherapy*, (Rome).

Erskine, R. G. (1998). Attunement and involvement: Therapeutic responses to relational needs. *Int. J. Psychother.* 3, 235–244.

Erskine, R. G. (2015). *Relational Patterns, Therapeutic Presence: Concepts and Practice of Integrative Psychotherapy*. London: Karnac Books.

Erskine, R. G. (2021). *A Healing Relationship. Commentary on Therapeutic Dialogues*. Quezon City: Phoenix Publishing House.

Erskine, R. G., and Moursund, J. P. (2011). *Integrative Psychotherapy in Action*. Thousand Oaks, CA: SAGE Publications.

Erskine, R. G., Moursund, J. P., and Trautmann, R. L. (1999). *Beyond Empathy: A Therapy of Contact-in-Relationship*. London: Psychology Press.

Fairbairn, W. R. D. (1952). *An Object-Relations Theory of the Personality*. New York, NY: Basic Books.

Fairbairn, W. R. D. (1986/1941). "A revised psychopathology of the psychoses and psychoneuroses," in *Essential Papers on Object Relations*, ed. P. Buckley (New York, NY: New York University Press), 71–101.

Feldt, L. S. (1980). A test of the hypothesis that Cronbach's alpha reliability coefficient is the same for two tests administered to the same sample. *Psychometrika* 45, 99–105.

Gorsuch, R. L. (1983). *Factor Analysis*. Mahwah, NJ: Lawrence Erlbaum.

Hazan, C., and Shaver, P. (1987). Romantic love conceptualized as an attachment process. *J. Pers. Soc. Psychol.* 52, 511–524. doi: 10.1037/0022-3514.52.3.511

Hesse, E. (1999). "The adult attachment interview: Historical and current perspectives," in *Handbook of Attachment: Theory, Research, and Clinical Applications*, eds J. Cassidy and P. Shaveer (New York,NY: Guilford Press), 395–433.

Holgado-Tello, F. P. (2015). "Análisis de los ítems [item's analysis]," in *Psicometría [Psychometry]*, eds M. B. Barbero, E. Vila, and F. P. Holgdo-Tello (Madrid: UNED), 385–444.

Hu, L., and Bentler, P. M. (1999). Cut-off criterion for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Struct. Equ. Model.* 6, 1–55. doi: 10.1080/10705519909540118

Kasser, V. G., and Ryan, R. M. (1999). The relation of psychological needs for autonomy and relatedness to vitality, well-being, and mortality in a nursing home. *J. Appl. Psychol.* 29, 935–954. doi: 10.1111/j.1559-1816.1999.tb00133.x

Kohut, H. (1971). *The Analysis of the Self*. New York, NY: International Universities Press.

La Guardia, J. G., and Patrick, H. (2008). Self-determination theory as a fundamental theory of close relationships. *Can. Psychol.* 49, 201–209. doi: 10.1037/a0012760

La Guardia, J. G., Ryan, R. M., Couchman, C. E., and Deci, E. L. (2000). Within-person variation in security of attachment: A self-determination theory perspective on attachment, need fulfillment, and well-being. *J. Pers. Soc. Psychol.* 79, 367–384. doi: 10.1037/0022-3514.79.3.367

Lorenzo-Seva, U., and Ferrando, P. J. (2006). FACTOR: A computer program to fit the exploratory factor analysis model. *Behav. Res. Methods* 38, 88–91. doi: 10.3758/bf03192753

Lorenzo-Seva, U., Timmerman, M. E., and Kiers, H. A. L. (2011). Dimensionality assessment of ordered polytomous items with parallel analysis. The Hull method for selecting the number of common factors. *Multivar. Behav. Res.* 46, 340–364. doi: 10.1080/00273171.2011.564527

Mardia, K. V. (1970). Measures of multivariate skewness and kurtosis with applications. *Biometrika* 57, 519–530. doi: 10.1093/biomet/57.3.519

Maslow, A. H. (1987). *Motivation and Personality*, 3rd Edn. London: Pearson Education.

Pourová, M., Øiháèek, T., and Žvelc, G. (2020). Validation of the Czech version of the Relational Needs Satisfaction Scale. *Front. Psychol.* 11:359. doi: 10.3389/fpsyg.2020.00359

Reise, S. P., Moore, T., and Haviland, M. (2010). Bifactor models and rotations: Exploring the extent to which multidimensional data yield univocal scale scores. *J. Pers. Assess.* 92, 544–550. doi: 10.1080/00223891.2010.496477

Reise, S. P., Scheines, R., Widaman, K. F., and Haviland, M. G. (2013). Multidimensionality and structural coefficient bias in structural equation modeling a bifactor perspective. *Educ. Psychol. Measur.* 73, 5–26. doi: 10.1177/0013164412449831

Ryan, R. M., and Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am. Psychol.* 55, 68–78. doi: 10.1037/0003-066X.55.1.68

Ryan, R. M., and Deci, E. L. (2017). *Self-Determination Theory. Basic Psychological Needs in Motivation, Development and Wellness*. New York: Guilford Press.

Ryff, C. D. (1989). Beyond Ponce de Leon and life satisfaction: New directions in quest of successful aging. *Int. J. Behav. Dev.* 12, 35–55. doi: 10.1177/016502548901200102

Satorra, A. (2002). Asymptotic Robustness in Multiple Group Linear-latent Variable models. *Econ. Theory* 18, 297–312. doi: 10.1017/S0266466602182041

Satorra, A., and Bentler, P. M. (1990). Model conditions for asymptotic robustness in the analysis of linear relations. *Comput. Stat. Data Anal.* 10, 235–249. doi: 10.1016/0167-9473(90)90004-2

Schermelleh-Engel, K., Moosbrugger, H., and Müller, H. (2003). Evaluating the fit of structural equation models: Test of significance and descriptive goodness-of-fit measures. *Methods Psychol. Res.* 8, 23–74.

Schore, A. N. (1994). *Affect Regulation and the Origin of the Self*. Mahwah, NJ: Lawrence Erlbaum Associates Inc.

Schore, A. N. (2001). The effects of early relational trauma on right brain development, affect regulation, and infant mental health. *Infant Mental Health J.* 22, 201–269. doi: 10.1002/1097-0355(200101/04)22:1

Schore, A. N. (2003). *Affect Dysregulation And Disorders Of The Self*. New York, NY: W.W. Norton & Company.

Siegel, D. J. (1999). *The Developing Mind: Toward a Neurobiology of Interpersonal Experience*, 2nd. Edn. New York, NY: The Guilford Press.

Sousa, V. D., and Rojjanasrirat, W. (2011). Translation, adaptation and validation of instruments or scales for use in cross-cultural health care research: A clear and user-friendly guideline. *J. Eval. Clin. Practice* 17, 268–274. doi: 10.1111/j.1365-2753.2010.01434.x

Stern, D. (1985). *The Interpersonal World of the Infant. A View from Psychoanalysis and Developmental Psychology*. New York, NY: Basic Books.

Toksoy, S. E., Cerit, C., Aker, A. T., and Žvelc, G. (2020). Relational needs satisfaction scale: Reliability and validity study in Turkish. *Anatolian J. Psychiatry* 21, 37–44. doi: 10.5455/apd.115143

Trevelyan, E. G., and Robinson, N. (2015). Delphi methodology in health research: How to do it? *Eur. J. Integr. Med.* 7, 423–428. doi: 10.1016/j.eujim.2015.07.002

Van Dierendonck, D. (2004). The construct validity of Ryff's scales of psychological well-being and its extension with spiritual well-being. *Pers. Individ. Dif.* 36, 629–643. doi: 10.1016/S0191-8869(03)00122-3

Vázquez, C., Duque, A., and Hervás, G. (2013). Satisfaction with life scale in a representative sample of Spanish adults: Validation and normative data. *Spanish J. Psychol.* 16:E82. doi: 10.1017/sjp.2013.82

Velicer, W. F. (1976). Determining the number of components from the matrix of partial correlations. *Psychometric* 41, 321–327. doi: 10.1007/BF02293557

Wallin, D. J. (2007). *Attachment in Psychotherapy*. New York, NY: The Guilford Press.

Winnicot, D. W. (1986/1960). "The theory of the parent-infant relationship," in *Essential Papers on Object Relations*, ed. P. Buckley (New York, NY: New York University Press), 233–254.

Žvelc, G., and Jovanoska, K. (2016). "Relational needs scale (RNS)," in *Institute for Integrative Psychotherapy and Counselling*, (Ljubljana).

Žvelc, G., and Jovanoska, K. (2017). "The development of the relational needs scale," in *8th International Integrative Psychotherapy Conference*, (Milan).

Žvelc, G., Jovanoska, K., and Žvelc, M. (2020). Development and validation of the Relational Needs Satisfaction Scale. *Front. Psychol.* 11:901. doi: 10.3389/fpsyg.2020.00901

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 23 September 2022
DOI 10.3389/fpsyg.2022.1002830

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OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Movement Science and Sport Psychology, a section of the journal Frontiers in Psychology

RECEIVED 25 July 2022
ACCEPTED 17 August 2022
PUBLISHED 23 September 2022

CITATION
Du Z and Zhang X (2022) Analysis of the mediating effects of self-efficacy and self-control between physical activity and Internet addiction among Chinese college students.
Front. Psychol. 13:1002830.
doi: 10.3389/fpsyg.2022.1002830

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Analysis of the mediating effects of self-efficacy and self-control between physical activity and Internet addiction among Chinese college students

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It explores the roles of self-efficacy and self-control in physical activity and Internet addiction. And it further provides a theoretical basis for the treatment and improvement of Internet addiction among college students. This study employs the whole group sampling method. The questionnaire was conducted on 855 college students from five universities in three provinces using the Physical Activity Level Scale, the General Self-Efficacy Scale, the Self-Control Scale, and the Chinese Internet Addiction Scale (IAS). The analyses yielded three main findings. (1) A large amount of physical activity was helpful in reducing the symptoms of Internet addiction and the problematic status of each dimension among college students. (2) A large or moderate amount of physical activity was helpful in enhancing college students' self-efficacy. Besides, a large amount of physical activity was likely to enhance college students' self-control. (3) The condition of physical activity not only directly has the negative correlation with college students' Internet addiction but also influences college students' Internet addiction through two indirect ways: the mediating role of self-control and the chain mediating role of self-efficacy and self-control. These conclusions provide a deeper understanding of the protective factors of Internet addiction among Chinese college students.

KEYWORDS

Internet addiction, self-efficacy, self-control, chain mediating effect, Chinese college students

Introduction

Internet addiction refers to the phenomenon of losing control of the impulsion to use the Internet without the effect of addictive substances. The typical symptoms are excessive or poorly controlled obsessions and cravings as well as the related behaviors of impairment in academic performance, occupation and social engagement (Ndasauka et al., 2019). It is tested that the combined rate of Internet addiction among Chinese college students is 11% which is higher than some other countries. And the rate has

shown a slight upward trend and gradually stabilized in the past 3 years (Shao et al., 2018). College students are the largest potential group of Internet addiction with the most serious symptoms of Internet addition, as they become less restraint after being admitted in colleges (Li et al., 2021). Although Internet addiction is not yet listed as a disease, new diagnostic criteria for Internet gaming disorder (a subtype of Internet addiction) have been incorporated into DSM-V (Diagnostic and Statistical Manual of Mental Disorders-V) and ICD -11 (The International Classification of Diseases -11), and is defined as a mental disorder, which shows the increasing international attention to Internet addiction (Ndasauka et al., 2019). The excessive use of the Internet has a negative impact on sleep (Abolghasem et al., 2016), physical health (Güzel et al., 2018), self-esteem (Budak et al., 2015), academic performance (Singh and Srivastava, 2021), and mental health (Columb et al., 2021) among college students. It has already become one of the main factors affecting the academic performance of college students (Yuanyuan et al., 2015). The current situation of Internet addiction is so grim that it has aroused widespread concern from all walks of life. Rutter (1987) proposed the theoretical model of two-factor problem behavior that the study of the factors influencing problem behavior should not only focus on the factors that produce problem behavior i.e., risk factors but also on protective factors that can directly or indirectly reduce problem behavior (Rutter, 1987). As a protective factor of Internet addiction, this study explores the psychological influence mechanism of physical activity on Internet addiction and tries to combine social control theory with the control theory of Internet addiction so as to provide theoretical and practical support for the effective prevention and control of Internet addiction among college students.

Theories and hypotheses

Internet addiction from the perspective of exercise psychology

From the above analysis of the psychological attribution and damage of Internet addiction, it can be seen that the psychological mechanism of Internet addiction is relatively complex, including driving factors like needs, motivation and personality trait factors like depression, loneliness, poor self-control, high feeling seeking, negative coping styles. Combining these factors to explain Internet addiction, the most representative factors are Young's ACE model, Davis' cognitive-behavioral model and Grohol's stage model. Yinghai and Yujin (2009) believe that physical exercise conforms to the interpretation principles of three authoritative models of Internet addiction: ACE model, cognitive-behavior model and stage model, and can be used as an effective prevention and intervention method. The ACE model refers to the three underlying factors of availability, control and excitability to explain the formation process of compulsive Internet use. Physical exercise, as a network substitute, is closely related to personality in the process of satisfying individual needs (especially emotional needs, communication needs, self-actualization needs, etc.). Non-competitive exercise activities such as fitness and aerobic exercise have a two-way regulation function on mood, which can maintain negative mood or excessively benign mood state at the intermediate level, that is, the function of balance mechanism. Some competitive activities with outcome of winning or losing can help to improve the activation state of mood under certain conditions (Ji, 2006). Through physical exercise, individuals feel "fluid experience," "pleasure of physical exercise," "negative mood transfer experience," etc., and obtain individual needs and exciting experiences (Yinghai and Yujin, 2009); in cognitive-behavioral model theory, it is believed that there are major cognitive impairments in some specific aspects, thereby aggravating the symptoms of individual Internet addiction (Yinghai and Yujin, 2009). However, numerous studies have demonstrated a moderately positive correlation between physical activity and cognitive activity (Etnier et al., 1997). When the exercise is a coordinated action that requires thinking, and when the structure and function contained in these actions are necessary to engage in certain operations, physical exercise is beneficial to cognitive activities; Grohol (1999) proposed a stage model, which considered Internet addiction. It is a staged behavior. Internet users generally go through three stages. The first stage: the novice of the Internet is fascinated by the Internet, or the experienced Internet users are fascinated by the new application software; the second stage, the user begins to avoid Internet activities that lead to addiction; the third stage: The user's Internet activities and other activities have reached a balance. The role of physical exercise may be highlighted in the formation of a healthy sports lifestyle, or it can prevent being "fascinated" by the Internet again. Inspired by the interpretation of Grohol's stage model, this model provides the possibility and operability of physical exercise intervention for Internet addiction tendency, Internet addiction disorder and even severe Internet addiction.

Tool selection and symptom definition of Internet addiction

There are many tools for measuring Internet addiction, such as Young's Internet Addiction Test, Widyanto 's Internet Addiction Test, The Internet Addiction Scale (IAS) (Griffiths, 1998). However, considering the cultural background differences between regions and countries and the applicability to college students, this study selects the IAS compiled by Taiwanese scholar Chen et al. (2003) using college students as samples. The scale contains five common

symptoms of Internet addiction, compulsiveness, withdrawal symptoms, tolerance, interpersonal health problems, and time management problems. They are used as tool-measured dimensions. Here is the introduction to the definitions of the five dimensions: (1) Obsessiveness: The individual has an inextricable desire and urge to surf the Internet (Chen et al., 2003). (2) Withdrawal symptoms: If you do not surf the Internet for a period of time, you will become obviously restless and uncontrollably want to surf the Internet, always worrying about what you are missing (Young, 1996). (3) Tolerance: Individuals need to continuously increase the time spent on the Internet to achieve their level of satisfaction (Young, 1996). (4) Interpersonal health problems: Individuals are alienated from family and friends because they indulge in the Internet for too long (Chen et al., 2003). (5) Time management problem: Individuals are delayed in their studies because they indulge in the Internet for too long (Chen et al., 2003).

Physical activity and Internet addiction

In addition to the negative effects of Internet addiction on academic performance and psychological health, Internet addiction can largely disrupt physical activity among college students (Lepp et al., 2013). Kim et al. (2015) found that Internet addiction may negatively affect college students' physical health by reducing the time spent on physical activity such as walking. Penglee et al. (2019) revealed that Internet addiction may be a barrier for college students to participation in physical activity and they proposed strategies to promote physical activity in higher education situations. Similarly, Barkley and Lepp (2016) stated that excessive use of the Internet among college students can be considered as a sedentary leisure behavior which leads to poor physical activity. Meanwhile, Yinghai and Yujin (2009) argued that physical activity is consistent with the explanatory principles of three authoritative models of Internet addiction, the ACE model, the cognitive-behavioral model, and the stage model. And it can be an effective method to prevent and intervene the addition. Previous studies have found that physical activity can significantly improve the symptoms of Internet addiction (Gao et al., 2012; Li et al., 2020). The results of the Meta-analysis by Jin et al. (2018) also support the above view. In clinical psychology, treatment of psychological disorders and addictive disorders, physical activity is usually used as a supplementary means by physicians or psychotherapists. However, the mechanisms through which physical activity affects college students' Internet addiction remain to be explored. Previous empirical studies have demonstrated the predictive effect of physical activity on Internet addiction, but the current study lacks insight into the underlying psychological mechanisms of the two. To bridge this gap, we explore the effects of physical activity on Internet addiction and sought to assess the positive effects of self-efficacy and self-control on Internet addiction.

Effect of different physical activity on Internet addiction

The current research on the effect of sports on Internet addiction is mainly intervention (Jun, 2017). A recent study extends the hierarchy to provide neurobiological and neuropsychological evidence for sports intervention on Internet addiction (Li et al., 2020), the focus of this type of research is still on whether sports are effective for Internet addiction, and no research has been conducted on the direction of what amount of exercise is most effective for Internet addiction. This study will also further verify the differences in internet addiction across three different levels of physical activity: large, medium and small.

Self-efficacy

Self-efficacy is first proposed by the famous psychologist Bandura. It refers to people's judgments about the ability needed to organize and perform a behavior in order to achieve a certain performance. It may affect and determine one's choice of activities and the effort one takes in the process of performance (Bandura, 1977, 1991). Self-efficacy is the core of the social cognitive theory which Bandura proposed. The higher one's level of self-efficacy is, the more confident he or she will be in accomplishing a behavior. In other words, he or she is more likely to perform it (Bandura, 2002). Zhengyu (2000), after analyzing the results of several studies at home and abroad, pointed out that effective participation in regular exercise can increase one's sense of effectiveness in physical activity, improve the state of mind, and promote satisfaction with life. Therefore, there is an interaction between physical activity and self-efficacy. Heydari and Dehghanizade (2018) randomly selected 50 drug users from all drug users in Yazd City and divided them into two groups of 25 (control and experimental), the experimental group received 6 weeks of selective exercise, the control group Without any training or intervention, the results showed that the above-mentioned selective exercise had a significant effect on the improvement of self-efficacy in the experimental group ($P < 0.05$). The empirical study of Sheng et al. (2016) measured the relationship between physical exercise and self-efficacy in 1,084 middle school students, and the results showed that physical exercise was significantly positively correlated with self-efficacy. At the same time, Berte et al. (2021) verified the relationship between Internet use patterns and self-efficacy by surveying 505 Palestinian college students, and the results showed that there was a high negative correlation between Internet addiction use patterns and self-efficacy. Yang

(2020) verified the effects of self-efficacy and self-control on Internet addiction among middle school students through a survey of 119 middle school students, and found that there was a significant negative correlation between self-efficacy and Internet addiction. Based on the above, hypothesis two is proposed: self-efficacy plays a mediating role in the influence of physical activity on Internet addiction among college students.

Self-control

Self-control is the ability to suppress immediate impulses and regulate one's behavior. Besides, it also includes the ability that individuals restrain their desires and needs and change their inherent behavioral thinking in order to live in harmony with the external environment. The ability of individuals to rationally regulate their emotions and behavior also is involved in the term self-control (Schmeichel et al., 2011). The limited self-control theory suggests that self-control requires the consumption of an individual's resources and that lacking self-control can easily lead to addition behaviors (Baumeister et al., 2018). Previous studies have shown the positive correlation between physical activity and self-control including physical activity of different intensities (Sibley et al., 2006), different periods (Pesce et al., 2009), different types of physical activity and exercise programs (Pesce et al., 2009; Davis et al., 2011). However, Kamijo et al. (2007) noted that high-intensity physical activity may not enhance one's self-control, which is contrary to the study of Davis et al. (2011). In addition, studies at home and abroad both have found that those with higher level of Internet addiction always have lower levels of self-control (Qifeng et al., 2013b; Akın et al., 2015). Li et al. (2020) meta-analysis of 83 primary studies with 80,681 participants determined whether students with poor self-control had greater Internet addiction, the results showed that self-control was negatively associated with Internet addiction related. Enyuan and Huiyu (2017) conducted a survey of 1,500 Chinese college students and found that self-control has a significant negative predictive effect on Internet addiction. Therefore, Hypothesis 3 is proposed: self-control plays a mediating role in the influence of physical activity on Internet addiction among college students.

Self-efficacy and self-control

Bandura argues in his social learning theory that self-efficacy and self-control both are internal factors of the individual self. The individual factor is the driving force for the individual's behaviors and has a direct impact on them (Bandura, 1991). Bandura holds the view that self-control is influenced by self-efficacy (Bandura, 1977). It has been noted that (Hamedani, 2013; Džinović et al., 2019) self-efficacy can directly affect self-control. The higher the self-efficacy is, the higher the self-control is. This also indicates that self-efficacy plays an important role in the construction of one's self-control. In addition, previous studies have shown that both self-efficacy and self-control have significant negative predictive effects with Internet addiction. Ju et al. (2019) investigated 440 college students to verify the relationship between self-efficacy, self-control, and mobile phone addiction. The results showed that self-efficacy and self-control were significantly positively correlated, and indicated that self-efficacy was an indirect influence on smartphone addiction through self-control. Therefore, Hypothesis 4 was proposed: Self-efficacy and self-control play a chain mediating role between physical activity and Internet addiction.

Current research

Previous studies exploring the relationship between physical activity and Internet addiction have mostly been intervention studies (Jun, 2017) and meta-analyses (Qiao et al., 2020). Few studies have directly explored the psychological mechanism of the impact of physical activity on Internet addiction. Despite the findings of studies showing that demographic characteristics (Farahani et al., 2018), mental illness (Farahani et al., 2018), personality disorders (Farahani et al., 2018), nostalgia (Ni et al., 2009), gender (Ni et al., 2009), neuroticism score (Tsai et al., 2009), and healthy behaviors (Tsai et al., 2009) are the influencing factors of Internet addiction. In addition, Burnay et al. (2015) used an ensemble model to collect data of 644 respondents revealed that psychological factors such as urgency, lack of perseverance, obsessive passion, and depression were all predictors of Internet addiction. However, the underlying psychological mechanisms of important psychological variables such as self-efficacy and self-control in the relationship between physical activity and Internet addiction are still unclear.

In summary, this study focused on Chinese college students and analyzed the differences between different physical activity levels on each dimensions including self-efficacy, self-control, Internet addiction. Based on this and combined with previous theories of discussing the correlation among self-efficacy, self-control, physical activity, and Internet addiction, it aims to verify the possible mechanisms of self-efficacy and self-control between physical activity and Internet addiction in order to provide the reference for reducing the Internet addiction of college students.

Data sources and methods

Research objects

This study employed cluster random sampling method. Based on class, it selected 950 college students (from freshman to senior) as research subjects. They come from Beijing, Henan

and Inner Mongolia provinces and all study in the universities or colleges covering a number of fields and disciplines to like Beijing Normal University, Zhengzhou University, Henan College of Engineering, Zhongyuan Institute of Science and Technology, Inner Mongolia University of Science and Technology. The information related to the study subjects is detailed in Table 1. The inclusion criteria of the subjects: (1) College students (full-time only), including vocational colleges, and undergraduate colleges, while excluding college students majoring in physical education and psychology; (2) Clear consciousness. They are able to successfully complete the questionnaire without history of mental illness; (3) Voluntary participation in the investigation of this study; (4) Informed consent for the investigation work, the counselor (class teacher) issued an informed consent form, and filled out the questionnaire after signing; (5) Physical health, not included in clinical patients.

Investigation procedure

First, the staff explained the purpose and method of the study to the respondents face to face and solved their doubts in person. With the consent of the counselor (or head teacher) and the person himself or herself, the questionnaire was filled out anonymously, without involving personal information such as student number. Then, the electronic questionnaire in the form of Questionnaire Star was distributed to the participants *via* WeChat group. It took about 10 min to answer all questions. Among the 1,000 people who received electronic questionnaires, 950 people returned questionnaires (95% response rate). In order to ensure the accuracy of the data and the robustness of the structural equation model, the returned questionnaires were strictly screened to exclude invalid responses, short responses (less than 5 min), and 10 consecutive questions with the same options (each question was answered with the same answer, such as "11111111. " or "2222222222."), and pattern responses (e.g., "11111111.")., pattern responses (following certain artificial rules, such as "7, 6, 5, 4, 3, 2, 1, 7, 6, 5, 4, 3, 2, 1. " or "5, 5, 5, 4, 4, 4, 4, 3, 3, 2, 2, 2, 2, 1, 1, 1.") to obtain a valid questionnaire. 855 valid questionnaires were obtained and the questionnaire efficiency rate was 90%. Each participant was given a small gift (such as a tip or a voucher) as a reward to thank you for participating in the survey. In accordance with local laws and institutional requirements, no ethical review or informed consent signed by the participants was required for this study. However, the process to ensure informed consent of all participants to participate was still included in the survey. When subjects accessed the electronic questionnaire, all information in the document appeared on the first page. The document stated that the survey was anonymous and that its results would be used only for scientific research without any risk to their daily lives. It also told them that participation in the study was completely voluntary. Subjects could only take the questionnaire after confirming that they had read the document and agreed to participate in the study.

TABLE 1 Subjects' information (Mean ± *SD*).

Classification	Category	Number of people	Percentage (%)	Age (years)
Total	–	855	100	19.96 ± 2.68
Gender	Male	497	58.2	20.02 ± 3.17
	Female	358	41.8	19.66 ± 1.79
Grade	Freshman year	509	59.5	18.13 ± 0.78
	Sophomore	140	16.4	18.93 ± 1.37
	Junior	149	17.5	19.67 ± 1.65
	Senior year	57	6.7	21.19 ± 1.35

Measures

Physical activity level scale

The scale was compiled by the Japanese scholar Koyo Hashimoto (2005) and revised by Deqing (1994). The scale consists of 3 dimensions: intensity, duration and frequency. Each dimension has 1 item, which is scored by Likert 5 points. It follows the formula that "intensity × (time - 1) × frequency = total physical activity score." A score of ≤ 19 indicates a small amount of physical activity, 20–42 indicates a moderate amount of physical activity, and ≥ 43 indicates a large amount of physical activity. The higher the score, the greater the amount of physical activity. The scale has high reliability and validity, with a retest reliability of 0.82. The total Cronbach's alpha for this scale in this study was 0.774.The CFA model demonstrated a satisfactory fit [normed chi square (x^2/df) = 4.109, comparative fit index (CFI) = 0.995, goodness of fit index (GFI) = 0.975, Tucke-Lewis index (TLI) = 0.977, root meansquare error of approximation (RMSEA) = 0.066, standardized root mean square residual (SRMR) = 0.037]. Following the recommendations of Schumacker and Lomax (2016), this scale was suitable for the sample studied.

General self-efficacy scale

The scale was compiled by Schwarzer et al. (1995). The Chinese version was translated and revised by Caikang et al. (2001). The scale consists of 10 items, and is scored on a 4-point Likert scale, with scores from 1 to 4 corresponding to "not at all correct" to "completely correct," with higher scores indicating stronger general self-efficacy. The reliability and validity of the scale are high, with a retest reliability of 0.83. The total Cronbach's alpha for this scale in this study was 0.97.The CFA model demonstrated a satisfactory fit (x^2/df = 3.3, CFI = 0.957, GFI = 0.9, TLI = 0.945, RMSEA = 0.02, SRMR = 0.015). Following the recommendations of Schumacker and Lomax (2016), this scale was suitable for the sample studied.

Self-control scale

The scale was compiled and published by American scholar Tangney et al. (2004) and later revised by Shuhua and Yongyu (2008). 19 items were selected from the initial 36 items and scored on a 5-point scale, with scores ranging from 1 to 5 corresponding to " completely inconsistent" to " completely consistent," among which questions 1, 5, 11, and 14 are scored positively, and the remaining items are scored backward. The higher the total score, the stronger the self-control. The scale has 5 dimensions, namely impulse control (α = 0.932), healthy habits (α = 0.927), resisting temptation (α = 0.913), focusing on work (α = 0.906), and abstaining from entertainment (α = 0.916). The scale has high reliability and validity with a retest reliability of 0.85. The total Cronbach's alpha for this scale in this study was 0.97.The CFA model demonstrated a satisfactory fit (x^2/df = 3.00, CFI = 0.98, GFI = 0.95, TLI = 0.976, RMSEA = 0.02, SRMR = 0.03). Following the recommendations of Schumacker and Lomax (2016), this scale was suitable for the sample studied.

Chinese Internet addiction scale

The scale was compiled in 1999 by Taiwanese scholars Chen et al. (2003) with college students as subjects. It has 5 dimensions including compulsiveness (α = 0.886), withdrawal symptoms (α = 0.93), tolerance (α = 0.911), interpersonal health problems (α = 0.895) and time management problems (α = 0.908), with a total of 26 question items, using Likert 4-point scale. The higher total scores indicating a higher tendency to Internet addiction. If the total score is ≥ 58, the preliminary screening is a potential Internet addict. If the total score is ≥ 68, it is diagnosed as an Internet addict. The scale has high reliability and validity with a retest reliability of 0.83. The total Cronbach's alpha for this scale in this study was 0.976.The CFA model demonstrated a satisfactory fit (x^2/df = 6.338, CFI = 0.924, GFI = 0.945, TLI = 0.915, RMSEA = 0.029, SRMR = 0.021). Following the recommendations of Schumacker and Lomax (2016), this scale was suitable for the sample studied.

Statistical methods

First, descriptive statistics, reliability test, one-way ANOVA and Pearson correlation analysis were carried out on self-efficacy, self-control, physical activity and Internet addiction after normality test using SPSS 21.0. *Post hoc* multiple tests were conducted for different groups using the LSD method. Then, use Amos 24.0 software to do structural equation model and fit the chain mediation effect model to analyze the model fit. Secondly, after standardizing each research variable, the hierarchical multiple regression equation was standardized, and the equation model was analyzed by mediating effect with physical activity as the independent variable, self-efficacy and self-control as the mediating variables, and Internet addiction as the dependent variable. Incremental changes in R^2 and F values in the results were used to assess the main effects of the study variables. Finally, after standardizing each research variable, the macro program process in SPSS was used to test the significance of the mediation effect through the bias-corrected non-parametric percentile Bootstrap method (resampled 5,000 times) (Preacher and Hayes, 2008), confidence interval No 0 is significant ($P < 0.05$; Hooper et al., 2008).

Results

Common method bias test

Harman's single factor test (Podsakoff et al., 2003) was used to conduct factor analysis on all the items involved in this study. The results showed that 11 factors with eigenvalues greater than 1 were extracted by exploratory factor analysis. And the variance explained by the first factor was 20.966%, which was much lower than the critical value of 40%, which indicated that the data in this study were not affected by the common method bias.

Differences in the effects of physical activity amount on self-efficacy, self-control, and Internet addiction

The results of the analysis showed that the main effect of physical activity amount on self-efficacy ($F = 22.69$, $p < 0.01$) and self-control ($F = 26.55$, $p < 0.001$) was statistically significant, i.e., physical activity had an effect on self-efficacy and self-control. *Post hoc* multiple comparisons revealed that college students with a large amount and moderate physical activity showed higher self-efficacy than those with a small amount of physical activity ($P < 0.01$) In terms of self-control, college students with a large amount of physical activity showed higher self-control compared to moderate physical activity and moderate physical activity compared to a small amount of physical activity ($P < 0.01$), as shown in **Table 2**.

The main effect of the amount of physical activity on each dimension was statistically significant with Internet addiction ($F = 33.95$, $p < 0.01$) and compulsiveness ($F = 22.1$, $p < 0.01$), withdrawal symptoms ($F = 29.85$, $p < 0.01$), tolerance ($F = 34.34$, $p < 0.01$), interpersonal health problems ($F = 28.86$, $p < 0.01$), and time management problems ($F = 31.61$, $p < 0.01$). That is to say, physical activity had an effect on Internet addiction and its other dimensions. *Post hoc* multiple comparisons revealed that a large amount of physical activity was significantly lower than individuals with moderate and small amounts of physical activity on internet addiction and its dimensions of compulsivity, withdrawal symptoms, tolerance, interpersonal health problems, and time management problems ($P < 0.01$), i.e., a large amount of physical activity compared to a small

TABLE 2 Analysis of differences in variables by physical activity groups ($M \pm SD$).

Projects	Category	*n*	Self-efficacy	Self-control	Internet addiction	Compulsive	Withdrawal symptoms	Tolerance	Interpersonal health issues	Time management issues
Sports grade	Small	342	2.7 ± 0.65	3.05 ± 0.67	3.73 ± 0.55	3.61 ± 0.57	3.74 ± 0.56	3.75 ± 0.6	3.72 ± 0.61	3.83 ± 0.64
	Medium	274	2.93 ± 0.73	3.28 ± 0.85	3.61 ± 0.64	3.5 ± 0.69	3.62 ± 0.67	3.63 ± 0.69	3.61 ± 0.68	3.71 ± 0.71
	Big	239	3.01 ± 0.66	3.53 ± 0.82	3.32 ± 0.62	3.25 ± 0.7	3.34 ± 0.65	3.3 ± 0.67	3.31 ± 0.67	3.37 ± 0.72
Statistics analysis	*F*		22.69**	26.55**	33.95**	22.1**	29.85**	34.34**	28.86**	31.61**
	Partialη^2		0.05	0.06	0.07	0.05	0.07	0.08	0.06	0.07
	R^2		0.05	0.06	0.07	0.05	0.06	0.07	0.06	0.06
After the fact multiple compare	LSD		Middle > Small**	Middle > Small**	Medium > Small	Medium > Small	Medium > Small	Medium > Small	Medium > Small	Medium > Small
			Big > Small**	Big > Small**	Big > Small**	Big > Small**	Big > Small**	Big > Small**	Big > Small**	Big > Small**
			Large > Medium	Large > Medium**	Large > Medium**	Large > Medium**	Large > Medium**	Large > Medium**	Large > Medium**	Large > Medium**

**$p < 0.01$.

amount of physical activity and moderate college students showed less problematic behaviors for internet addiction (see Table 2).

Analysis of the relationship among college students' physical activity, self-efficacy, self-control and Internet addiction

The Pearson correlation analysis showed (see Table 3) that physical activity was significantly positively correlated with self-efficacy and self-control ($r = 0.31$, $P < 0.001$; $r = -0.26$, $P < 0.001$) and negatively correlated with Internet addiction and its dimensions (compulsiveness, withdrawal symptoms, tolerance, interpersonal health problems, and time management problems) ($r = -0.27$, $P < 0.001$). Self-efficacy and self-control were significantly negatively correlated with Internet addiction and its dimensions (compulsiveness, withdrawal symptoms, tolerance, interpersonal health problems, and time management problems) ($r = -0.23$, $P < 0.001$; $r = -0.57$, $P < 0.001$). Self-efficacy was significantly positively correlated with self-control ($r = 0.42$, $P < 0.001$). The significant correlations among the main variables indicated that further tests for mediating effects could be conducted (Wen et al., 2004).

Relationship between physical activity and Internet addiction

This study uses Amos 24.0 to conduct structural equation model analysis to examine the mediating effect of self-efficacy and self-control between physical activity and Internet addiction. The fitting index of the model was: $\chi^2/df = 3.29$, $p < 0.001$, GFI = 0.91, CFI = 0.92, RMSEA = 0.05, which met the requirements of psychometrics. The equation model uses the amount of physical activity as the independent variable with self-efficacy and self-control as the mediating variable as well as Internet addiction as the dependent variable for the mediating effect analysis. The results are shown in Table 4. Physical activity positively predicted self-efficacy ($\beta = 0.31$, $P < 0.001$). Physical activity positively predicted self-control ($\beta = 0.14$, $P < 0.001$). Self-efficacy positively predicted self-control ($\beta = 0.38$, $P < 0.001$). Physical activity negatively predicted Internet addiction ($\beta = -0.14$, $P < 0.001$). Self-control negatively predicted Internet addiction ($\beta = -0.55$, $P < 0.001$).

Also, the mediation effects of each mediation path were examined by Bootstrap method (5,000 repetitions of sampling) (Wen et al., 2004). The results were showed in Table 5 and Figure 1. The 95% confidence intervals for total indirect effects, direct effects (C'), $a_2 b_2$ and $a_1 a_3 b_2$ did not contain 0, indicating that the effects of these pathways were significant. The effect size of the direct effect path accounted for 48.26%, and the

TABLE 3 Descriptive statistics and correlation analysis of each variable.

Variables	Mean	*SD*	Physical exercise	Self-efficacy	Self-control	Internet addiction	Compulsive	Withdrawal symptoms	Tolerance	Interpersonal health issues	Time management issues
Physical exercise	3.82	0.80	1.00								
Self-efficacy	2.88	0.70	0.28**	1.00							
Self-control	3.26	0.80	0.25**	0.47**	1.00						
Internet addiction	3.58	0.62	−0.25**	−0.24**	−0.54**	1.00					
Compulsive	3.48	0.66	−0.21**	−0.23**	−0.52**	0.88**	1.00				
Withdrawal symptoms	3.59	0.64	−0.24**	−0.24**	−0.51**	0.96**	0.82**	1.00			
Tolerance	3.59	0.67	−0.24**	−0.2**	−0.48**	0.95**	0.76**	0.9**	1.00		
Interpersonal health issues	3.57	0.67	−0.23**	−0.19**	−0.49**	0.93**	0.76**	0.86**	0.9**	1.00	
Time management issues	3.66	0.71	−0.23**	−0.21**	−0.5**	0.91**	0.72**	0.85**	0.87**	0.86**	1.00

**$p < 0.01$.

effect of physical activity on Internet addiction was significant indicating that physical activity has a direct relationship with college students' Internet addiction. The mediating effect of self-control between physical activity and Internet addiction was significant (95%CI = −0.081, −0.030) and the proportion of effect size was 26.87%. The chain mediating effect of self-efficacy and self-control between physical activity and Internet addiction was significant (95%CI = −0.068, −0.034) and the effect size was 24.88%. The confidence interval of $a_1 b_1$ contained 0 (95%CI = −0.004, 0.027), indicating that the mediating effect of self-efficacy between physical activity and Internet addiction was not significant.

Discussion

In this study, the questionnaire method was used to investigate and analyze the current situation of college students' physical activity and Internet addiction during the normalized epidemic prevention period. And this study analyzed the influence of physical activity on Internet addiction among college students and the mediating role of self-efficacy and self-control between them.

Differences in each variable between different physical activity amount

This study found that participation in a high level of physical activity was more likely to reduce the symptoms of Internet addiction and its dimensions (compulsivity, withdrawal symptoms, tolerance, interpersonal health problems, and time management problems) among college students than moderate and small levels of physical activity. According to the correlation analysis between physical activity and Internet addiction, it is found that physical activity significantly had a negative correlation with Internet addiction among college students, i.e., the more they participated in physical activity, the less their symptoms like compulsive, withdrawal symptoms, tolerance, interpersonal health problems, and time management problems. This result is consistent with previous studies (Gao et al., 2012; Jin et al., 2018; Li et al., 2020). Both the Internet and physical activity provide participants with a sense of interaction and entertainment. The difference between the two is that the engagement of the Internet puts one into the virtual world. While physical activity allows one to experience the real world and will guide and build the physical and mental health of the participants. One of the theoretical foundations of sports intervention therapy is that physical activity participation can occupy the time spent on the Internet, while at the same time subconsciously influencing the participants' physiology and psychology toward positive changes. The participation of physical activity can not

TABLE 4 Regression analysis of chain mediation model ($N = 855$).

Variables	Equation 1: (Dependent variable: Self-efficacy)			Equation 2: (Dependent variable: Self-control)			Equation 3: (Dependent variable: Internet addiction)		
	β	SE	*t*	β	SE	*t*	β	SE	*t*
Physical activities	0.31	0.03	8.05***	0.14	0.04	3.64***	−0.14	0.02	−3.87***
Self-efficacy				0.38	0.05	10.16***	0.04	0.03	1.24
Self-control							−0.55	0.03	−12.65***
R^2	0.10			0.2			0.34		
F	70.66***			135.53***			122.85***		

***$p < 0.001$.

only effectively improve the condition of adolescent Internet addiction and the physical condition of addicts, but also contribute to promoting psychological health, exercising will and the ability of suppressing Internet addiction (Jin et al., 2018).

This study also found that the level of participation in a large amount of physical activity is more conducive to improving the self-efficacy level of college students than the level of moderate and small physical activity. In terms of self-control ability, college students with a lot of physical activity showed higher self-control ability than moderate physical activity and moderate physical activity compared with a small amount of physical activity. This is also consistent with the theoretical model of the psychological benefits of physical activity in adolescents proposed by Tomporowski et al. (2011). Based on this, the present study proved that self-efficacy and self-control, two important psychological factors, played a mediating role in the effect of physical activity on Internet addiction.

The mediating role of self-efficacy in physical activity and college students' Internet addiction was not significant

In this study, self-efficacy was significantly positively correlated with physical activity, and significantly negatively correlated with Internet addiction, but the mediating effect of self-efficacy between physical activity and college students' Internet addiction was not significant, which was inconsistent with previous research theoretical implications (Heydari and Dehghanizade, 2018; Yang, 2020; Berte et al., 2021). Although numerous findings suggest a mediating role of self-efficacy between physical activity and Internet addiction, no empirical studies have directly confirmed this. As for the insignificant mediating effect of self-efficacy, our explanation is: on the one hand, the general self-efficacy scale used may refer to general and overall self-efficacy (Schwarzer et al., 1995; Caikang et al., 2001), and self-efficacy includes specific self-efficacy perspectives, such as Internet rejection self-efficacy, Internet self-efficacy, social self-efficacy, emotion regulation self-efficacy, etc. If starting from a more specific self-efficacy, the relationship may be closer. Qifeng et al. (2013a) verified the close relationship between Internet rejection self-efficacy and Internet addiction through a survey of 420 Chinese college students, Luo et al. (2010) selected 1,121 students from five universities in Wuhan to conduct research, confirmed the significant correlation and close relationship between Internet use self-efficacy and Internet control self-efficacy and Internet addiction. On the other hand, it may be found by some empirical studies that the link between self-efficacy and Internet addiction may require indirect effects of other variables (Cheng et al., 2019). And follow-up studies should verify this.

TABLE 5 Bootstrap analysis of the mediating effect test.

Paths	Effect	BootSE	Boot95% CI		Effect size ratio
			Lower limit	Upper limit	
C'	−0.097	0.023	−0.142	−0.042	48.26%
a_1 b_1	0.011	0.008	−0.004	0.027	–
a_2 b_2	−0.054	−0.013	−0.081	−0.030	26.87%
a_1 a_3 b_2	−0.050	0.009	−0.068	−0.034	24.88%
Total indirect effect	−0.104	0.016	−0.125	−0.064	51.75%
Total effect	−0.201	0.0257	−0.24	−0.139	100%

C', physical activity → Internet addiction; a1b1, physical activity → self-efficacy → internet addiction; a2b2, physical activity → self-control → Internet addiction; a1a3b2, physical activity → self-efficacy → self-control → Internet addiction; a1b1 has the opposite sign of the C' effect size. And its proportion does not have a good effect size, so it is no longer expressed.

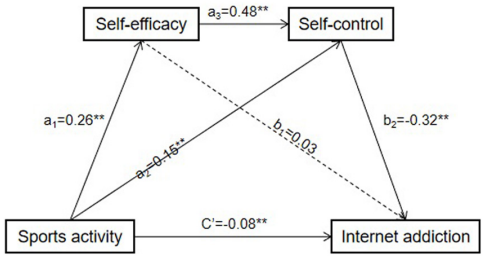

FIGURE 1
Chain mediation model of physical activity on Internet addiction. **$P < 0.01$.

Self-control plays a mediating role between physical activity and college students' Internet addiction

Another important finding of this study was that self-control played a partially mediating role in physical activity on Internet addiction among college students, with an effect value of 26.87% of the total indirect effect. This supports the previous findings (Yang et al., 2019), which indicates that individuals with higher levels of self-control are able to overcome their internal desires and rationally regulate their emotions and behaviors to achieve their goals. Therefore, they can rationally control their behaviors of using the Internet and avoid forming the Internet addiction symptoms. Based on the dual system theory of self-control, self-control is composed of two systems: impulse and control. The impulse system is the process of automatic response to tempting situations such as emotions, new and different incentives and rewards. The control system, on the other hand, is a higher-order system that inhibits various impulsive responses (Schmeichel et al., 2011). People who score higher in the control system are better able to weigh and consider the consequences afterward due to their higher rational psychological quality and develop higher-order evaluation and suppression criteria when faced with temptations (Yang et al., 2019), thus suppressing the cyber-addictive behavioral impulses.

Self-efficacy and self-control play a chain mediating role among college students' Internet addiction

Another important finding of this study was that self-efficacy and self-control played a chain mediating role in the effect of physical activity on college students' Internet addiction, with an effect value of 24.88% of the total indirect effect. It can be seen that physical activity promotes self-control by enhancing self-efficacy, which in turn reduces college students' Internet addictive behaviors. Besides, the effect between self-efficacy and Internet addiction was mediated by self-control, which suggests that an increase in self-efficacy can promote a reduction in the level of Internet addiction. But this process may occur through an increase in internal self-control. Therefore, the more college students participate in physical activity, the stronger their self-efficacy and self-control subsequently increases. Therefore, regular physical activities can gradually promote the formation of a psychological positive circle, which in turn affects the improvement of Internet addiction symptoms.

Summary

The above findings support and extend the theory of physical activity treatment for Internet addiction providing ideas for intervention correction of Internet addiction. The study also has some theoretical and practical guidance for the treatment of Internet addiction in college students, especially for the suppression of addictive behavioral impulses according to the pathway of physical activity influencing Internet addiction. Most of the research centers in the field of psychology focusing on explaining the formation mechanism of addictive behaviors but lack effective interventions and treatment methods. While the change and development of healthy behaviors can be more directly applied to individual health promotion. Aiming at the individual factors of Internet addiction, we can cultivate regular sports behavior habits to affect the enhancement of self-efficacy

and self-control, thereby directly or indirectly inhibiting out-of-control behavior and reducing Internet addiction.

Limitations

It is important to note the limitations of this study. First, this study used a cross-sectional design so it may have implications for revealing causal relationships between variables. In future studies, using a longitudinal design can help provide a developmental perspective. This study found some valuable results, but there were also certain research flaws: there was a sampling bias. The whole-group sampling method of distributing the questionnaire resulted in a biased sample of subjects in terms of gender, i.e., with more males and fewer females. This sampling bias may have some impact on the external validity of the study results. In addition, some scholars believe that addictive disorders have gender differences. In this study, only the whole group of college students was considered, and there is no separate analysis of male and female college students. Considering the representativeness of the sample in this study, future research will expand the scope of the survey to increase it to examine the relationship between physical activity and Internet addiction.

Conclusion

A large amount of physical activity was more helpful in reducing college students' Internet addiction symptoms and problems of each dimension. Large and moderate amounts of physical activity were more helpful in enhancing college students' self-efficacy. And a large amount of physical activity was more likely to enhance college students' self-control. Physical activity both directly and negatively predicted college students' Internet addiction. Physical activity could influence college students' Internet addiction through two indirect ways: the mediating role of self-control and the chain mediating role of self-efficacy and self-control. These findings may provide a deeper understanding of the protective factors of Internet addiction among Chinese college students.

Data availability statement

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

ZD conceived, designed the study, performed the data analysis, wrote the Chinese manuscript, and wrote and supplemented the English manuscript. XZ participated in the manuscript revision. ZD and XZ participated in the data collection and collation. Both authors contributed to the article and approved the submitted version.

Funding

This study was supported by the National Social Science Foundation of China (Grant No. 21BTY035) and the Research and Innovation Project for University Students in Henan Province (Grant No. S202110459005).

Acknowledgments

We thank the sports psychology research team of Beijing Normal University, Zhengzhou University and all the participants for their great contributions. We thank to the Mayday band for giving us hope in the toughest of times.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Abolghasem, P., Eftekhari, M., Rezania, S., Jafarisani, M., Soleimani, R., and Khalafi, A. (2016). Studying the relationship between quality of sleep and addiction to internet among students. *Nova J. Med. Biol. Sci.* 5, 1–7. doi: 10.20286/jmbs-050303

Akın, A., Arslan, S., Arslan, N., Uysal, R., and Sahranç, Ü (2015). Self-control management and internet addiction. *Int. Online J. Educ. Sci.* 7, 95–100. doi: 10.15345/iojes.2015.03.016

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychol. Rev.* 84, 191–215. doi: 10.1037/0033-295X.84.2.191

Bandura, A. (1991). Social cognitive theory of self-regulation. *Organ. Behav. Hum. Decis. Process.* 50, 248–287. doi: 10.1016/0749-5978(91)90022-L

Bandura, A. (2002). Social cognitive theory in cultural context. *Appl. Psychol.* 51, 269–290. doi: 10.1111/1464-0597.00092

Barkley, J. E., and Lepp, A. (2016). Mobile phone use among college students is a sedentary leisure behavior which may interfere with exercise. *Comput. Hum. Behav.* 56, 29–33. doi: 10.1016/j.chb.2015.11.001

Baumeister, R. F., Bratslavsky, E., Muraven, M., and Tice, D. M. (2018). "Egodepletion: Is the active self a limited resource?," in *Self-regulation and self-control*, (London: Routledge), 16–44. doi: 10.4324/9781315175775-1

Berte, D. Z., Mahamid, F. A., and Affouneh, S. (2021). Internet addiction and perceived self-efficacy among university students. *Int. J. Ment. Health Addict.* 19, 162–176. doi: 10.1007/s11469-019-00160-8

Budak, E., Taymur, I., Askin, R., Gungor, B., Demirci, H., Akgul, A., et al. (2015). Relationship between internet addiction, psychopathology and self-esteem among university students. *Eur. Res. J.* 1, 128–135. doi: 10.18621/eurj.2015.1.3.128

Burnay, J., Billieux, J., Blairy, S., and Larøi, F. (2015). Which psychological factors influence internet addiction? Evidence through an integrative model. *Comput. Hum. Behav.* 43, 28–34. doi: 10.1016/j.chb.2014.10.039

Caikang, W., Zhongfeng, H., and Yong, L. (2001). Research on the reliability and validity of general selfefficacy scale. *Appl. Psychol.* 7, 37–40.

Chen, S.-H., Weng, L.-J., Su, Y.-J., Wu, H.-M., and Yang, P.-F. (2003). The development and psychometric properties of the Chinese internet addiction scale. *Chin. J. Psychol.* 45, 279–294. doi: 10.1037/t44491-000

Cheng, J. W., Fang, Y. P., and Yang, S. (2019). General self-efficacy and internet addiction in higher education students: The mediating role of coping styles. *Chin. J. Health Psychol.* 4, 623–627. doi: 10.13342/j.cnki.cjhp.2019.04.037

Columb, D., Keegan, E., Griffiths, M. D., and O'Gara, C. (2021). A descriptive pilot survey of behavioural addictions in an adolescent secondary school population in Ireland. *Ir. J. Psychol. Med.* 1, 1–13. doi: 10.1017/ipm.2021.40

Davis, C. L., Tomporowski, P. D., Austin, B. P., Miller, P. H., Yanasak, N. E., Allison, J. D., et al. (2011). Exercise improves executive function and achievement and alters brain activation in overweight children: A randomized, controlled trial. *Health Psychol.* 30, 91–98. doi: 10.1037/a0021766

Deqing, L. (1994). Stress level of college students relationship with physical exercise. *Chin. J. Health* 1, 5–6.

Džinović, V., Đević, R., and Đerić, I. (2019). The role of self-control, self-efficacy, metacognition, and motivation in predicting school achievement. *Psihologija* 52, 35–52. doi: 10.2298/PSI180202027D

Enyuan, Z., and Huiyu, Z. (2017). An empirical study on the relationship between subjective well-being, self-control and Internet addiction of college students. *J. Grad. Sch. Chin. Acad. Soc. Sci.* 5, 17–24.

Etnier, J. L., Salazar, W., Landers, D. M., Petruzzello, S. J., Han, M., and Nowell, P. (1997). The influence of physical fitness and exercise upon cognitive functioning: A meta-analysis. *J. Sport Exerc. Psychol.* 19, 249–277. doi: 10.1123/jsep.19.3.249

Farahani, M., Alavi, S. S., Bafghi, M. M., Alamuti, S. E., Taghavi, Z., and Mohammadi, M. (2018). Psychological factors including demographic features, mental illnesses, and personality disorders as predictors in internet addiction disorder. *Iran. J. Psychiatry* 13, 103–110.

Gao, J., Sun, J., and Xiao, K. (2012). An empirical study of the effects of physical activity intervention on college students' internet addiction. 2011 a new species of the genus Gao Jun (Coleoptera, Staphylinidae) from China. *J. Shenyang Sports Coll.* 55–59.

Griffiths, M. (1998). "Internet addiction: Does it really exist?," in *Psychology and the internet: Intrapersonal, interpersonal, and transpersonal implications*, ed. J. Gackenbach (Cambridge, MA: Academic Press), 61–75.

Grohol, J. M. (1999). Too much time online: Internet addiction or healthy social interactions? *Cyberpsychol. Behav.* 2, 395–401. doi: 10.1089/cpb.1999.2.395

Güzel, N., Kahveci, Ý., Solak, N., Cömert, M., and Turan, F. N. (2018). Internet addiction and its impact on physical health. *Turk. Med. Stud. J.* 5, 32–36. doi: 10.4274/tmsj.2018.05.03.0002

Hamedani, S. H. H. (2013). The relationship between self-efficacy and self-regulation in vocabulary acquisition of Iranian EFL learners. *J. Acad. Appl. Stud.* 3, 20–31.

Hashimoto, K. (2005). The relationship between exercise and mental health: A life stage perspective. *J. Health Sci.* 27, 27–32.

Heydari, M., and Dehghanizade, J. (2018). Effect of a period of selective aerobic exercises on self-efficacy. *Happiness Mindfulness Addicts* 11, 23–41.

Hooper, D., Coughlan, J., and Mullen, M. R. (2008). Structural equation modelling: Guidelines for determining model fit. *Electron. J. Business Res. Methods* 6, 141–146.

Ji, L. (2006). *Physical exercise and mental health*. Shanghai: East China Normal University Press.

Jin, W., Hui, Z., Zhenzhong, D., and Wenjun, W. (2018). Meta-analysis of the effect of exercise prescription on Internet addiction in adolescents. *Sports Sci.* 39, 46–54. doi: 10.13598/j.issn1004-4590.2018.03.008

Ju, H. J., Jun, H. S., and Park, M. K. (2019). The stress, self-efficacy, and self-control of university students impact on smartphone addiction. *J. Digit. Converg.* 17, 395–407.

Jun, L. (2017). Intervention study of exercise prescription and psychological counseling on college students' internet addiction. *J. Guangzhou Inst. Phys. Educ.* 3, 73–75. doi: 10.13830/j.cnki.cn44-1129/g8.2017.03.020

Kamijo, K., Nishihira, Y., Higashiura, T., and Kuroiwa, K. (2007). The interactive effect of exercise intensity and task difficulty on human cognitive processing. *Int. J. Psychophysiol.* 65, 114–121.

Kim, S. E., Kim, J. W., and Jee, Y. S. (2015). Relationship between smartphone addiction and physical activity in Chinese international students in Korea. *J. Behav. Addict.* 4, 200–205. doi: 10.1556/2006.4.2015.028

Lepp, A., Barkley, J. E., Sanders, G. J., Rebold, M., and Gates, P. (2013). The relationship between cell phone use, physical and sedentary activity, and cardiorespiratory fitness in a sample of U.S. college students. *Int. J. Behav. Nutr. Phys. Act.* 10:79. doi: 10.1186/1479-5868-10-79

Li, S., Wu, Q., Tang, C., Chen, Z., and Liu, L. (2020). Exercise-based interventions for internet addiction: Neurobiological and neuropsychological evidence. *Front. Psychol.* 11:1296. doi: 10.3389/fpsyg.2020.01296

Li, Y. Y., Sun, Y., Meng, S. Q., Bao, Y. P., Cheng, J. L., Chang, X. W., et al. (2021). Internet addiction increases in the general population during COVID-19: Evidence from China. *Am. J. Addict.* 30, 389–397. doi: 10.1111/ajad.13156

Luo, C.-H., Wan, J. J., Liu, Q.-X., and Fang, X.-Y. (2010). The relationship between internet use, internet-specific self-efficacy, and internet addiction among college students. *Psychol. Dev. Educ.* 26, 618–626.

Ndasauka, Y., Pitafi, A., and Kayange, G. M. (2019). Psychometric properties of Young's internet addiction test (IAT) in Urdu language. *Asian J. Psychiatry* 40, 39–44. doi: 10.1016/j.ajp.2019.01.011

Ni, X., Yan, H., Chen, S., and Liu, Z. (2009). Factors influencing internet addiction in a sample of freshmen university students in China. *Cyberpsychol. Behav.* 12, 327–330. doi: 10.1089/cpb.2008.0321

Penglee, N., Christiana, R. W., Battista, R. A., and Rosenberg, E. (2019). Smartphone use and physical activity among college students in health science-related majors in the United States and Thailand. *Int. J. Environ. Res. Public Health* 16:1315. doi: 10.3390/ijerph16081315

Pesce, C., Crova, C., Cereatti, L., Casella, R., and Bellucci, M. (2009). Physical activity and mental performance in preadolescents: Effects of acute exercise on free-recall memory. *Ment. Health Phys. Act.* 2, 16–22.

Podsakoff, P. M., Mackenzie, S. B., Lee, J. Y., and Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *J. Appl. Psychol.* 88, 879–903. doi: 10.1037/0021-9010.88.5.879

Preacher, K. J., and Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behav. Res. Methods* 40, 879–891. doi: 10.3758/BRM.40.3.879

Qiao, S., Li, Y., and Liu, L. (2020). Mesh meta-analysis of the effects of different interventions for adolescent internet addiction. *Chin. Sch. Health* 41, 1167–1173.

Qifeng, H., Zhi, Z., and Zi, Y. (2013b). A study on the differences in Internet behavior, personality psychological characteristics and self-control ability of college students with different Internet addiction states. *J. Zhejiang Univ. (Sci. Edn.)* 1, 106–111.

Qifeng, H., Zi, Y., and Lanlan, C. (2013a). Discussion on the relationship between Internet addiction and Internet rejection self-efficacy and Internet self-efficacy of college students. *J. Zhejiang Univ. (Sci. Edn.)* 4, 483–488.

Rutter, M. (1987). Psychosocial resilience and protective mechanisms. *Am. J. Orthopsychiatry* 57, 316–331. doi: 10.1017/CBO9780511752872.013

Schmeichel, B. J., Vohs, K. D., and Duke, S. C. (2011). Self-control at high and low levels of mental construal. *Soc. Psychol. Pers. Sci.* 2, 182–189. doi: 10.1177/1948550610385955

Schwarzer, R., and Jerusalem, M. (1995). Generalized self-efficacy scale. J. Weinman, S. Wright, and M. Johnston, measures in health psychology: A user's portfolio. *Causal Control Beliefs* 35:37.

Schumacker, R. E., and Lomax, R. G. (2016). *A beginner's guide to structural equation modeling*, 4th Edn. London: Routledge. doi: 10.4324/9781315749105

Shao, Y. J., Zheng, T., Wang, Y. Q., Liu, L., Chen, Y., and Yao, Y. S. (2018). Internet addiction detection rate among college students in the People's Republic of China: A meta-analysis. *Child Adolesc. Psychiatry Ment. Health* 12:25. doi: 10.1186/s13034-018-0231-6

Sheng, J., Gao, S., and Tang, G. (2016). The effect of physical exercise on secondary school students' psychological health: The mediating role of self-efficacy. *Chin. Sports Sci. Technol.* 52, 98–103+135.

Shuhua, T., and Yongyu, G. (2008). Revision of the self-control scale for college students. Chin. *J. Clin. Psychol.* 5, 468–470.

Sibley, B. A., Etnier, J. L., and Le Masurier, G. C. (2006). Effects of an acute bout of exercise on cognitive aspects of stroop performance. *J. Sport Exerc. Psychol.* 28, 285–299.

Singh, A., and Srivastava, D. K. (2021). Understanding the effect of internet addiction on student academic engagement. *Int. J. Inf. Commun. Technol. Educ.* 17, 1–12. doi: 10.4018/IJICTE.20211001.oa11

Tangney, J. P., Baumeister, R. F., and Boone, A. L. (2004). *The self control scale*. Fairfax, VA: George Mason University. doi: 10.1037/t19593-000

Tomporowski, P. D., Lambourne, K., and Okumura, M. S. (2011). Physical activity interventions and children's mental function: An introduction and overview. *Prev. Med.* 52(Suppl. S), S3–S9. doi: 10.1016/j.ypmed.2011.01.028

Tsai, H. F., Cheng, S. H., Yeh, T. L., Shih, C. C., Chen, K. C., Yang, Y. C., et al. (2009). The risk factors of internet addiction-a survey of university freshmen. *Psychiatry Res.* 167, 294–299. doi: 10.1016/j.psychres.2008.01.015

Wen, Z., Zhang, L., Hou, J., and Liu, H. (2004). Mediation effect test procedure and its application. *J. Psychol.* 36, 614–620.

Yang, G., Tan, G. X., Li, Y. X., Liu, H. Y., and Wang, S. T. (2019). Physical exercise decreases the mobile phone dependence of university students in China: The mediating role of self-control. *Int. J. Environ. Res. Public Health* 16:4098. doi: 10.3390/ijerph16214098

Yang, S. Y. (2020). Effects of self-efficacy and self-control on internet addiction in middle school students: A social cognitive theory-driven focus on the mediating. *Child Health Nurs. Res.* 26, 357–365. doi: 10.4094/chnr.2020.26.3.357

Yinghai, L., and Yujin, D. (2009). Internet addiction psychological attribution and intervention research from the perspective of exercise psychology. *J. Beijing Sport Univ.* 8, 57–61. doi: 10.19582/j.cnki.11-3785/g8 .2009.08.016

Young, K. (1996). "Internet addiction: The emergence of a new clinical disorder," in *The 104th annual meeting of the American Psychological Association, August 20, 1996*, Toronto, ON.

Yuanyuan, G., Huagang, Y., and Jiayuan, Y. (2015). The relationship between Internet addiction and academic delayed gratification and academic procrastination among college students. *China Health Serv. Manage.* 6, 463–465.

Zhengyu, T. (2000). Self-esteem, self-confidence, selfefficacy and sports. *J. Phys. Educ.* 1, 104–106. doi: 10.16237/j.cnki .cn44-1404/g8.2000.01.041

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 10 October 2022
DOI 10.3389/fpsyg.2022.1009347

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OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Personality and Social Psychology, a section of the journal Frontiers in Psychology

RECEIVED 01 August 2022
ACCEPTED 21 September 2022
PUBLISHED 10 October 2022

CITATION
Wanqing H, Fenqing L and Solodukho A (2022) Smartphone addiction and cross-cultural adjustment among overseas Chinese students: The role of emotion regulation beliefs and strategies. *Front. Psychol.* 13:1009347. doi: 10.3389/fpsyg.2022.1009347

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Smartphone addiction and cross-cultural adjustment among overseas Chinese students: The role of emotion regulation beliefs and strategies

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Background: Few studies have focused on the cross-cultural adjustment of Chinese students studying in Belarus with the size of this group increasing in recent years. The current study aimed to map the process of cross-cultural adjustment onto various factors including childhood emotional neglect, emotion regulation beliefs, emotional regulation strategies, and smartphone addiction in the international students. Emotional regulation strategy and emotion regulation beliefs could perform as key parts in adapting into overseas life from social learning perspective. Furthermore, smartphone addiction could precipitate a failed adjustment process.

Materials and methods: A total of 356 Chinese students in Belarus completed a self-administered questionnaire including the Chinese versions of the 12-item general health questionnaire (GHQ-12), sociocultural adaptation scale, mobile phone addiction tendency scale for college students, emotion regulation questionnaire, emotion and regulation beliefs scale, and childhood trauma questionnaire-short form. Correlation analysis, regression analysis and *T*-tests were used to explore the relationship between the variables. Structural equation modeling was carried out to test the hypotheses for association.

Results: Emotion regulation beliefs of international students mediated the effect of childhood emotional neglect on cross-cultural adjustment through expression suppression and smartphone addiction. While, in another chain mediation model, childhood emotional neglect affected cross-cultural adjustment only through emotion regulation beliefs and smartphone addiction. Cognitive appraisal independently influenced adjustment through smartphone addiction.

Limitations: Limitations include its cross-sectional design and self-reported survey methodology. In the future, we can combine experimental manipulations to explore the mechanisms by which various emotion beliefs act on smartphone addiction and cross-cultural adjustment in different situations.

Conclusion: This study displays the correlation between emotion regulation beliefs to smartphone addiction and cross-cultural adjustment, as well as the harmful effects of childhood emotional neglect; these components should be further addressed in future studies.

KEYWORDS

cross-cultural adjustment, smartphone addiction, emotional regulation strategies, emotion regulation beliefs, childhood emotional neglect

Introduction

The number of Chinese students studying abroad has been increasing in recent decades. The data show that the total number of Chinese international students in 2019 was 703,500 (Moe.gov.cn, 2022). In the academic year 2020–2021 more than 7,000 Chinese students studying in Belarus (Ministry of Education of the Republic of Belarus, 2022) and more than 30,000 Chinese students studying in Russia (Ministry of Science and Higher Education of the Russian Federation, 2022). China has many cultural concepts that are very different from those in the West (Jain, 2006). For example, Chinese tend to hold more collectivist attitudes than Russians (Tu et al., 2011), which can lead a more indirect way in communication (Gulbro and Herbig, 1999) and may affect the cross-cultural adjustment of Chinese students in Russian-speaking regions.

University students are in the stage of emerging adulthood, a period of high prevalence of mental health disorders (Arnett et al., 2014). Studying abroad gives international students the opportunity to receive a high level of education, but it also raises a variety of mental health issues. In February 2022, the situation in Ukraine deteriorated. According to Reuters (2022), there were casualties among foreign students in the eastern Ukrainian city of Kharkiv. The Russian–Ukrainian conflict has affected the mental and emotional state of university students in the region, with most reporting warfear about the war, stress, and angere (Kurapov et al., 2022). In addition, COVID-19 is spreading rapidly in Eastern Europe and this pandemic can have an impact on international students' anxiety, stress, and concerns about academic delays (Konstantinov et al., 2022). The unstable regional situation and the outbreak of COVID-19 may have a double mental impact on international students at the emerging adulthood. In the current crisis, it is of practical and theoretical importance to research the mechanisms influencing the cross-cultural adjustment of international students in order to promote the mental health of this group.

Cross-cultural adjustment

Cross-cultural adjustment includes psychological adaptation and sociocultural adaptation of individuals in a new social environment (Searle and Ward, 1990; Ward and Kennedy, 1994). Psychological adaptation refers to psychological and emotional wellbeing in cross-cultural encounters, and sociocultural adaptation refers to the ability to adapt to the local sociocultural environment (Ward and Kennedy, 1992). Previous studies have explored cross-cultural adjustment from the perspectives of personality, cultural intelligence and social support (Wang et al., 2015; Bender et al., 2019; Hu et al., 2020), but there is little research to uncover the capability of emotion regulation in the cross-cultural adjustment of international students.

Social cognitive theory emphasizes the importance of cognitive factors played in between the environment stimulus and behavior (Bandura, 1997). This theory suggests that there is a dynamic, triangle among cognition, environment and behavior. Based on social cognitive theory, individuals may develop maladaptive emotion beliefs as a result of experience of emotional neglect in childhood. These beliefs may affect their emotion regulation strategies in adulthood and eventually lead to cross-cultural adjustment problems.

Only a few studies investigated cross-cultural adjustment of international students in Russian-speaking regions. Shi conducted a survey of Chinese international students in Kyrgyzstan, and the results showed that the majority of Chinese international students suffered from varying degrees of depression (Shi, 2019). A survey of 351 international students in Russia showed that Chinese students had less adjustment skills and higher levels of depression compared to international students from other countries (Ju, 2011). However, there are barely studies focusing on the cross-cultural adjustment of Chinese students in Belarus. Therefore, the current study aims to investigate the factors influencing cross-cultural adjustment of Chinese students in Belarus from the social cognitive theory perspective. This could further contribute to the potential intervention to help international Chinese students to better adapt into the local culture.

Smartphone addiction

In the digital era, while smartphones bring convenience to international students, over-reliance on smartphones can also

negatively affect their physical and psychological health. A study conducted in Korea in 2015 reported that 40% of the Chinese international students were at-risk smartphone users (Kim et al., 2015). There are no studies have focused on smartphone addiction among international students in Russian-speaking regions.

Symptoms of smartphone addiction include "inability to control cravings," "anxiety and feeling lost," "withdrawal and escape," and "productivity loss" (Leung, 2008). Previous studies showed that smartphone addiction is associated with problems such as depression, anxiety, and realistic social avoidance (Elhai et al., 2017; Rozgonjuk et al., 2018; Wu et al., 2019), which may trigger a range of maladaptation problems in individuals. Despite the many negative effects that smartphone addiction may have on individuals' social adjustment, few studies have focused on the mechanisms underlying the international students' cross-cultural adjustment and the role played by smartphone addiction in this process.

Emotional regulation strategies

Expressive suppression and cognitive reappraisal are two commonly used emotional regulation strategies that are widely associated with individuals' psychological health. Expression suppression is a response-focused strategy that impedes individual emotional expression through response adjustment; cognitive reappraisal is an antecedent-focused strategy that alters emotional responses by changing the interpretation of the situation (Gross, 1998). It has been suggested that expression suppression and cognitive reappraisal act independently (Wang et al., 2007). Evidence from electrophysiological (EEG) and event related potential (ERP) suggests that different neurophysiological mechanisms exist for these two emotional regulation strategies (Sun et al., 2020).

Emotional regulation ability is an important factor influencing cross-cultural adjustment (Matsumoto et al., 2007). However, there are inconsistencies in the previous research findings. A survey of 245 international students in China during the epidemic found that psychological problems such as fear and hypochondriasis were significantly and negatively associated with both emotional regulation strategies (Xv et al., 2022). Interestingly, another survey of Chinese students in Ireland, however, found that expression suppression was not associated with poor psychological functioning in the Chinese student population (Sun and Nolan, 2021). In light of this, it is necessary to further discuss the relationship between expression suppression and cognitive reappraisal and international students' cross-cultural adjustment.

The way individuals regulate their emotions may have an impact on the consequences of their smartphone use (Fortes et al., 2021). It has been shown that expression suppression positively predicts smartphone use problems (Rozgonjuk and Elhai, 2021), cognitive reappraisal is positively associated with internet addiction (Trumello et al., 2018). Meanwhile, some researchers concluded that both expression suppression and cognitive reappraisal were significantly and negatively associated with smartphone addiction (Zhang and Jiang, 2017). On the other hand, other researchers emphasized that no emotional regulation strategy is beneficial or harmful under all the circumstances (Haines et al., 2016; Ford et al., 2019). Additionally, previous studies barely focused on the effect of emotional regulation strategies on smartphone addiction in international students.

Emotion regulation beliefs

Emotion regulation beliefs are the beliefs about whether emotions can be regulated, and they shape the individual's tendency toward emotion regulation strategies (Romero et al., 2014; Schroder et al., 2015), and may influence individuals' long-term development. Adults who tend to hold emotionally unregulated beliefs suffer from deteriorated mental health (De Castella et al., 2014; Ford et al., 2018).

Emotion regulation beliefs are related to an individual's tendency to use emotion regulation strategies. Several cross-sectional studies found that individuals' emotionally unregulated beliefs were not related to expression suppression, but were related to cognitive reappraisal (De Castella et al., 2013; Schroder et al., 2015). However, there is also evidence that individuals who hold emotionally unregulated beliefs are more likely to use expression suppression to regulate negative emotions (Wang, 2016). Ford and Gross noted that emotion regulation beliefs about experience may influence the choice of cognitive reappraisal, and emotion regulation beliefs about expression may influence the choice of expression suppression (Ford and Gross, 2018). Given the inconsistent findings of the previous studies, an in-depth discussion of the relationship between emotion regulation beliefs and emotional regulation strategies is necessary.

There is evidence that individuals who tend to believe that their emotions are unregulated have lower levels of social adaptation, and if individuals believe that they can regulate their emotions, they will have higher levels of social adaptation (Tamir et al., 2007). Therefore, emotion regulation beliefs may affect individuals' cross-cultural adjustment, and international students need to have high levels of emotion regulation beliefs in order to successfully complete cross-cultural adjustment.

Some studies have suggested that negative beliefs are markers of addictive behaviors (Hamonniere and Varescon, 2018). A person's negative beliefs may lead to problematic internet use behaviors (Spada and Caselli, 2017). Specifically, emotion beliefs predict symptoms of emotion dysregulation (Veilleux et al., 2021), and difficulties with emotion regulation are positively predictive of smartphone addiction (Ye et al.,

2017). However, no studies have focused on the role of emotion regulation beliefs in smartphone addiction and cross-cultural adjustment in international students.

Childhood emotional neglect

Childhood emotional neglect can have a negative impact on the individual (Cohen et al., 2017; Müller et al., 2019; Salokangas et al., 2019). Among the types of childhood maltreatment, emotional neglect is an implicit form of maltreatment that refers to the failure of caregivers to meet the emotional needs of children for normal development (Gilbert et al., 2009). It is estimated that approximately 18% of children worldwide suffer from emotional neglect each year (Stoltenborgh et al., 2015). A survey of adolescents in Henan, China, found that the prevalence of emotional neglect during childhood was 53.51% (Yu et al., 2020), which is higher than global estimates of the rate of emotional neglect in childhood. Because childhood emotional neglect occurs during a critical period of brain development, these adverse experiences may lead to changes in the structure and function of the human brain (Frodl et al., 2010; Maheu et al., 2010; Womersley et al., 2020), which subsequently affects the long-term health status of individuals.

Individuals' social adjustment and psychological wellbeing in adulthood can be affected by childhood emotional neglect (Wang et al., 2019). A study by Popescu et al. (2010) showed that adverse childhood experiences can affect social functioning in adulthood through individuals' coping styles. Although these studies point out that childhood emotional neglect can negatively affect individuals' adaptive development in adulthood, there is no research linking childhood emotional neglect to cross-cultural adjustment in international students, and it is necessary to explore the mechanisms at play.

Childhood emotional neglect is associated with the patterns in which individuals cope with their emotions. Previous research has shown that children as young as 6 years old have already formed reliable beliefs about specific forms of emotion regulation (Waters and Thompson, 2014). Young's schema theory proposes that adverse childhood experiences, contribute to individuals forming early maladaptive schemas about self and others (Young et al., 2003), also known as maladapted cognition. An individual's physical and psychological health can be affected by maladapted cognitions in a lasting way. However, to our knowledge, little research has been conducted to date on the relationship between childhood emotional neglect and emotion beliefs.

The current study

In sum, the previous studies have rarely explored the relationship between childhood emotional neglect, emotion regulation beliefs, emotional regulation strategies, smartphone addiction, and cross-cultural adjustment within a broad framework. The present study focused on two emotional regulation strategies, expression suppression and cognitive reappraisal. Given the possible differences in the mechanisms of action of these two emotion regulation strategies on smartphone addiction and cross-cultural adjustment in international students, and the fact that their relationship with individual psychological responses has not yet reached a consistent conclusion. Therefore, we proposed two models using social cognitive theory as the underlying framework (Liu and Ling, 2009). In these two models, we predicted that emotion regulation beliefs would mediate the relationship between childhood emotional neglect and cross-cultural adjustment (Hypothesis 1). Next, we predicted that emotional regulation strategies would mediate the relationship between emotion regulation beliefs and smartphone addiction (Hypothesis 2). Furthermore, we predicted that emotional regulation strategies would mediate the relationship between emotion regulation beliefs and cross-cultural adjustment (Hypothesis 3). Finally, we predicted that smartphone addiction would mediate the relationship between emotion regulation strategies and cross-cultural adjustment (Hypothesis 4). The conceptual models are shown in **Figures 1**, **2**.

Materials and methods

Study design and sample

The survey, based on a cross-sectional design, was conducted in Belarus in March 2022. Participants completed questionnaires online via *Wenjuanxing*.[1] All participants received a link to the questionnaire on their smartphones, which was posted on a WeChat group of Chinese students in Belarus. The questionnaire can be found in the **Supplementary material**. Participants first signed an informed consent form and then completed and submitted a questionnaire, and finally all participants received RMB 5 as incentives. The survey is completely anonymous and confidential and takes around 3–5 min to complete. The study was approved by the Ethics Committee of the Belarusian State University and was conducted according to the American Psychological Association guidelines in accordance with the 1964 Helsinki Declaration. The survey was preset up so that it could not be submitted without being totally completed, which helped to avoid the problem of missing values. Prior to data analysis, 15 invalid questionnaires (n = 371) were excluded because of (1) repeated submission; or (2) completing the entire questionnaire in

1 https://www.wjx.cn/

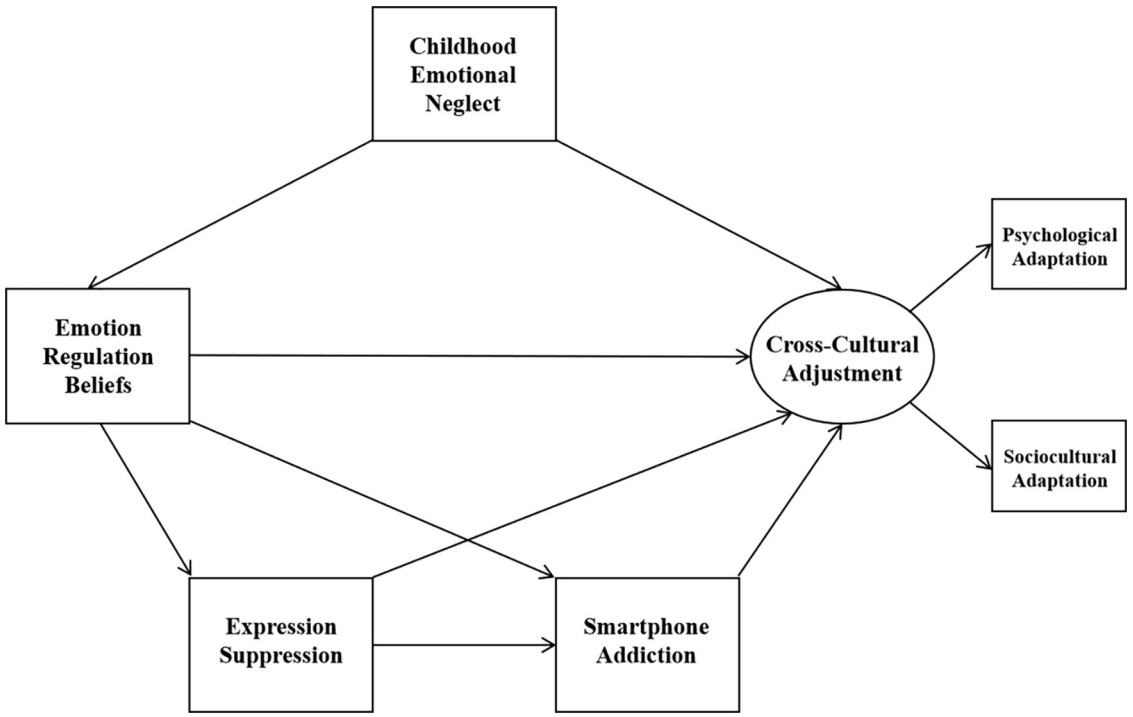

FIGURE 1
Model 1.

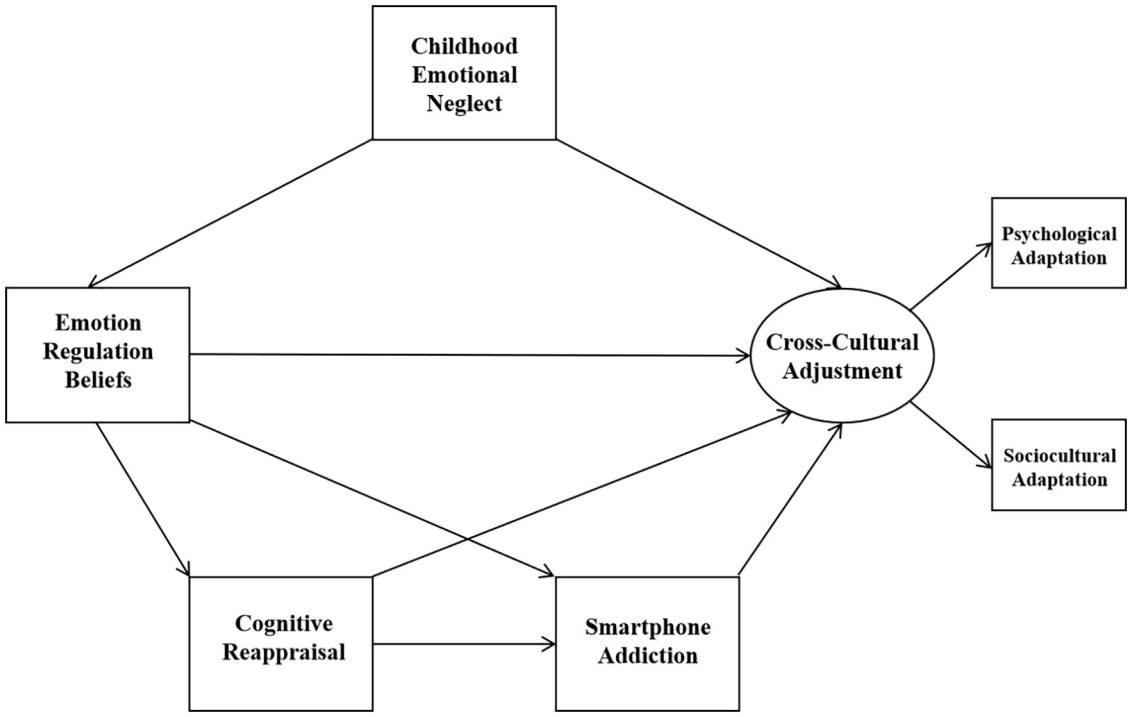

FIGURE 2
Model 2.

180 s and not understanding each question properly; or (3) choosing completely different answers to questions with similar meaning (For example: the truth is, I have difficulty controlling my emotions/no matter how hard I try, I have difficulty controlling my emotions). Thus, our final sample consisted of 356 Chinese students in Belarus, with a valid response rate of 95.96%.

Demographic characteristics of participants

Information on demographic data was gathered including age, gender, education level, number of siblings, parents' marital status, socioeconomic level, duration of stay in Belarus, and academic performance.

General health questionnaire-12 item

The 12-item general health questionnaire (GHQ-12) was used to measure the participants' psychological adaptation (Goldberg, 1978). The GHQ-12 consists of 12 Likert-style items using a 0-0-1-1 scoring system, ranging from "0" (not at all) to "1" (much more serious than usual), with a total score ranging from 0 to 12. The optimal cut-off score is 4. A score greater than or equal to 4 means that the participant is positive for mental disorder screening, i.e., poorly psychological adaptation, while a score less than 4 means that the participant is negative for mental disorder screening, i.e., well psychological adaptation. The reliability of the Chinese version of the GHQ-12 has been confirmed (Yang et al., 2003). The Cronbach's Alpha coefficient for this scale was 0.792.

Sociocultural adaptation scale

Sociocultural adaptation was measured by 15 items taken from the original 29 items of sociocultural adaptation scale (Ward and Kennedy, 1999). The scale consists of 15 Likert-type items scored on a five-point scale, ranging from "1" (extremely difficult) to "5" (no difficulty), with a total score ranging from 15 to 75, with scores approaching 75 indicating a better sociocultural adaptation of the respondent. This scale is adaptable and easily modified in terms of cultural appropriateness in a variety of research environments (Ward and Rana-Deuba, 1999). Tao adapted some of the SAS statements to match Chinese culture, for example, the items "worship" and "political system" were dropped as potentially misleading (Tao, 2012). The adapted version was used as the measurement instrument in this study. The Cronbach's Alpha coefficient for the scale was 0.905.

Mobile phone addiction tendency scale for college students

The mobile phone addiction tendency scale for college students was used to measure the participants' level of smartphone addiction (Xiong et al., 2012). The scale consists of 16 Likert-type items on a five-point scale, ranging from "1" (very unlikely) to "5" (fully likely), with a total score ranging from 16 to 80. The higher the score, the higher the level of smartphone addiction for that participant. The Cronbach's Alpha coefficient for this scale was 0.915.

Emotion regulation questionnaire

The emotion regulation questionnaire was used to measure participants' tendency to regulate their emotions (Gross and John, 2003). The scale consists of two dimensions (expression inhibition and cognitive reappraisal), with 10 Likert-type items on a seven-point scale, ranging from "1" (strongly disagree) to "7" (strongly agree), with a total score ranging from 10 to 70. The higher the score, the more often the participant used emotional regulation strategies. The reliability and validity of the Chinese version of this scale were confirmed to be at a reasonable level (Zhao et al., 2015). The Cronbach's alpha coefficients for the two dimensions of the questionnaire were 0.868 and 0.733, respectively, and the total Cronbach's alpha coefficient was 0.851.

Emotion and regulation beliefs scale

The emotion and regulation beliefs scale was used to measure participants' emotion regulation beliefs (Veilleux et al., 2015). The scale consists of 16 Likert-type items on a five-point scale, ranging from "1" (strongly disagree) to "5" (strongly agree), with total scores ranging from 16 to 80. The higher the score, the stronger the emotion regulation beliefs of that participant. Zhang adapted the ERBS to suit Chinese culture, for example, replacing "acknowledge" with "expression" in entry 11, and deleting three entries with a correlation coefficient of less than 0.30 with the total score (Zhang, 2018). The Cronbach's Alpha coefficient for the scale was 0.861.

Childhood trauma questionnaire-short form

The emotional neglect dimension of the childhood trauma questionnaire-short form was used to measure the degree of emotional neglect experienced by participants in childhood (Bernstein et al., 1998). The emotional neglect dimension

consists of five Likert-type items scored on a five-point scale, ranging from "1" (never) to "5" (always), with a total score ranging from 5 to 25. A higher score means that the participant experienced more childhood emotional neglect. The Chinese version of the CTQ-SF has reliable letter validity in a sample of Chinese university students (Zhang, 2011). The Cronbach's Alpha coefficient for the emotional neglect dimension was 0.791.

Statistical analysis

Statistical analysis was performed using SPSS 23.0 and statistical significance was determined with a two-tailed probability value of <0.05. The measured variables were tested for common method bias using a Harman one-way test with a 40% threshold criterion (Zhou and Long, 2004). Descriptive analyses were conducted on demographic variables. Correlations between measured variables were assessed using Pearson's correlations. Linear regression analysis was used to measure the effects of demographic characteristics on the measured variables. *T*-tests were used to examine the differences between different demographic variable groups on each variable. All measured variables involved in this study were standardized.

Mplus 8. 0 software was used for structural equation modeling (SEM) analysis to mediate the data. All the indicators involved in the SEM model had a good fit to the SEM criteria ($\chi^2/df < 5$, RMSEA < 0.08, CFI > 0.90, SRMR < 0.05) (Wheaton et al., 1977; MacCallum et al., 1996; Byrne, 1998; Hu and Bentler, 1999). For the mediation analysis, we extracted 5000 bootstrap samples and calculated 95% confidence intervals for bootstrap (BCa 95% CI) and two-tailed probability values < 0.05 being considered statistically significant. At the first stage of statistical analysis, the Harman one-way test was adapted to test for common method bias. As for that demographic statistics for research groups were calculated. At the second stage of analysis, correlation analysis were used to identify relationships between the variables (not included demographic variables). At the third stage of statistical analysis, a regression analysis was used to examine the prediction effect of demographic variables on "psychological" variables. At the fourth stage of statistical analysis, we used a *T*-test to identify differences across demographic variable groups on "psychological" variables. Finally, we tested hypothetical models using the SEM method.

Results

Description of the participants

Information on demographic characteristics is presented in **Table 1**.

TABLE 1 Demographic characteristics.

Variables	Range	Mean (SD)	
Age	18–35	23.45 (3.374)	
Variables		***n***	**%**
Gender	Male	180	50.6
	Women	176	49.4
Education level	Below bachelor's degree	36	10.1
	Bachelor's degree	158	44.4
	Master's degree and above	162	45.5
Are an only child or not	Only child	188	52.8
	Non-only child	168	47.2
Parents' marital status	Parents living together	312	87.6
	Divorced parents	44	12.4
Economic level	Poverty	34	9.6
	Not wealthy	56	15.7
	General	224	62.9
	Wealthy	42	11.8
Duration in Belarus	Under 6 months	93	26.1
	6–12 months	109	30.6
	1–2 years	48	13.5
	2–3 years	52	14.6
	More than 3 years	54	15.2
Academic performance	Bad	25	7.0
	General	133	37.4
	Good	157	44.1
	Excellent	41	11.5

Common method bias test

The Harman one-way test was adapted to test for common method bias. The results showed that the variance explained by the first common factor was only 12.35%, which was less than the critical value of 40%, indicating that there were no serious problems of common method bias in this study.

Correlations

The means, standard deviations and binary correlations between the measured variables are shown in **Table 2**. Smartphone addiction was significantly and positively correlated with expressive suppression and cognitive reappraisal, and significantly and negatively correlated with psychological adaptation, sociocultural adaptation and emotion regulation beliefs. Psychological adaptation was significantly and positively correlated with sociocultural adaptation, emotion regulation beliefs, and cognitive reappraisal, and was significantly and negatively correlated with childhood emotional neglect and expressive suppression.

Childhood emotional neglect was significantly and negatively associated with emotion regulation beliefs, cognitive reappraisal, and sociocultural adaptation. Sociocultural adaptation was significantly and positively associated with emotion regulation beliefs and cognitive reappraisal. Emotion regulation beliefs were significantly and negatively associated with expressive suppression. Cognitive reappraisal was significantly and positively correlated with expressive suppression.

Regression analysis

We examined the effect of demographic variables on cross-cultural adjustment using regression analysis. With all the variables entered in the regression model, the academic performance and duration of study abroad associated with psychological adaptation significantly, the academic performance and economic level associated with sociocultural adaptation significantly. The better the academic performance, the higher the degree of psychological adaptation (B = 0.174, p = 0.001); the longer the duration of study abroad, the higher the degree of psychological adaptation (B = −0.156, p = 0.003), while the other demographic variables had no significant predictive effect on psychological adaptation. The better the academic performance, the higher the level of sociocultural adaptation (B = 0.183, p = 0.001); the higher the economic level, the higher the level of sociocultural adaptation (B = 0.169, p = 0.001), and the other demographic variables were not significant predictors of sociocultural adaptation.

We also examined the predictive effect of demographic variables on expression suppression using regression analysis. With all the variables entered in the regression model, the education level associated with expression suppression significantly. The higher the education of international students, the less they used expression suppression to regulate their emotions (B = −0.139, p = 0.008), and the other demographic variables were not significant predictors of the use of expression suppression. In addition, demographic variables were not significant predictors of childhood emotional neglect, emotion regulation beliefs, cognitive reappraisal, and smartphone addiction.

T-test

We examined the differences across demographic variable groups on each variable using T-tests. Results found that in terms of childhood emotional neglect: participants in families with divorced parents suffered more childhood emotional neglect compared to participants in families with parents living together (T = −5.803, df = 354, p < 0.001), the difference in the degree of childhood emotional neglect was not significant in other groups with different demographic variables. Regarding the propensity to use expression suppression: male participants used expression suppression more often to regulate emotions compared to female participants (T = 2.804, df = 354, p = 0.005), and there were no significant differences in the propensity to use expression suppression across the other different demographic variable groups. In addition, there were no significant differences in the levels of psychological adaptation, sociocultural adaptation, smartphone addiction, cognitive reappraisal, and emotion regulation beliefs across the different demographic variable groups.

Results of structural equation model

As planned, the two hypothesized models (as depicted in Figures 1, 2) were examined using SEM method. Results found that Model 1 fit the data well, but Model 2 did not (Model 1: χ^2/df = 2.116, RMSEA = 0.056, CFI = 0.976, SRMR = 0.026; Model 2: χ^2/df = 6.738, RMSEA = 0.127, CFI = 0.840, SRMR = 0.057). However, we found the pathway from expression suppression to cross-cultural adjustment in Model 1 was not significant (p > 0.05) and the pathway from emotion regulation beliefs to cognitive reappraisal in Model 2 was not significant (p > 0.05). Therefore, we removed the pathway from expression suppression to cross-cultural adjustment in Model 1 and examined the refined model (named Model 3 and depicted in Figure 3). In addition, we removed the pathway from emotion regulation beliefs to cognitive reappraisal in Model 2 and examined the refined model (named Model 4 and depicted in Figure 4). Results show that both the Model 3 and Model 4 fit the data well (Model 3: χ^2/df = 1.961, RMSEA = 0.052, CFI = 0.975, SRMR = 0.028; Model 4: χ^2/df = 3.114, RMSEA = 0.077, CFI = 0.935, SRMR = 0.038).

Further path analyses were conducted to investigate indirect effects. The standardized indirect effect estimate, 95% confidence intervals, relative mediating effects, p-values, are shown in Table 3.

Mediation effects from childhood emotion neglect to cross-cultural adjustment through emotional regulation beliefs and expression suppression

The results showed that in Model 1, there was no significant indirect effect of emotion regulation beliefs on

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TABLE 2 Mean, standard deviation and bivariate correlation between measured variables (n = 356).

	M	SD	1	2	3	4	5	6
(1) Smartphone addiction	47.823	12.919	–					
(2) Psychological adaptation	6.536	2.792	−0.211**	–				
(3) Childhood emotional neglect	10.508	4.003	0.073	−0.149**	–			
(4) Sociocultural adaptation	59.797	10.275	−0.229**	0.281**	−0.215**	–		
(5) Emotion regulation beliefs	48.365	4.753	−0.350**	0.403**	−0.126*	0.212**	–	
(6) Cognitive reappraisal	30.379	5.804	0.202**	0.138**	−0.190**	0.212**	0.048	–
(7) Expressive suppression	17.544	4.522	0.386**	−0.109*	0.020	−0.043	−0.286**	0.434**

*$p < 0.05$, **$p < 0.01$.

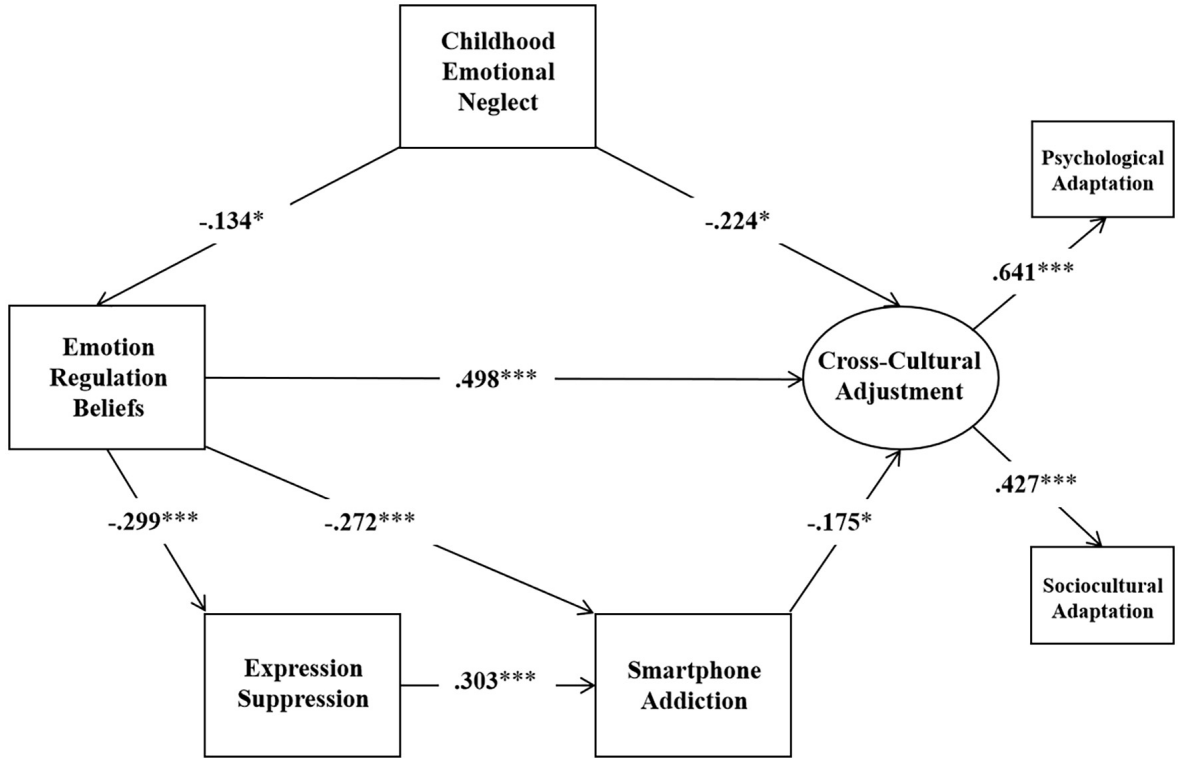

FIGURE 3
Model 3. *$p < 0.05$, ***$p < 0.001$.

cross-cultural adjustment through smartphone addiction, with a mediated effect size of 0.048 ($p > 0.05$, 95% confidence interval [0.006,0.114]); there was a significant indirect effect of childhood emotion neglect on cross-cultural adjustment through emotion regulation beliefs, with a mediated effect the amount of mediated effect was −0.067 ($p < 0.05$, 95% confidence interval [−0.136, −0.014]); emotion regulation beliefs have no significant indirect effect on cross-cultural adjustment, through the expression suppression as well as the role of smartphone addiction, the mediated effect size was 0.016 ($p > 0.05$, 95% confidence interval [0.003, 0.037]); emotion regulation beliefs had a significant indirect effect on smartphone addiction through expression suppression, with a mediated effect size of −0.091 ($p > 0.05$, 95% confidence interval [−0.143, −0.053]).

Mediation effects from childhood emotion neglect to cross-cultural adjustment through emotion regulation beliefs and cognitive appraisal

The results showed that in Model 2, cognitive reappraisal had a significant indirect effect on cross-cultural adjustment

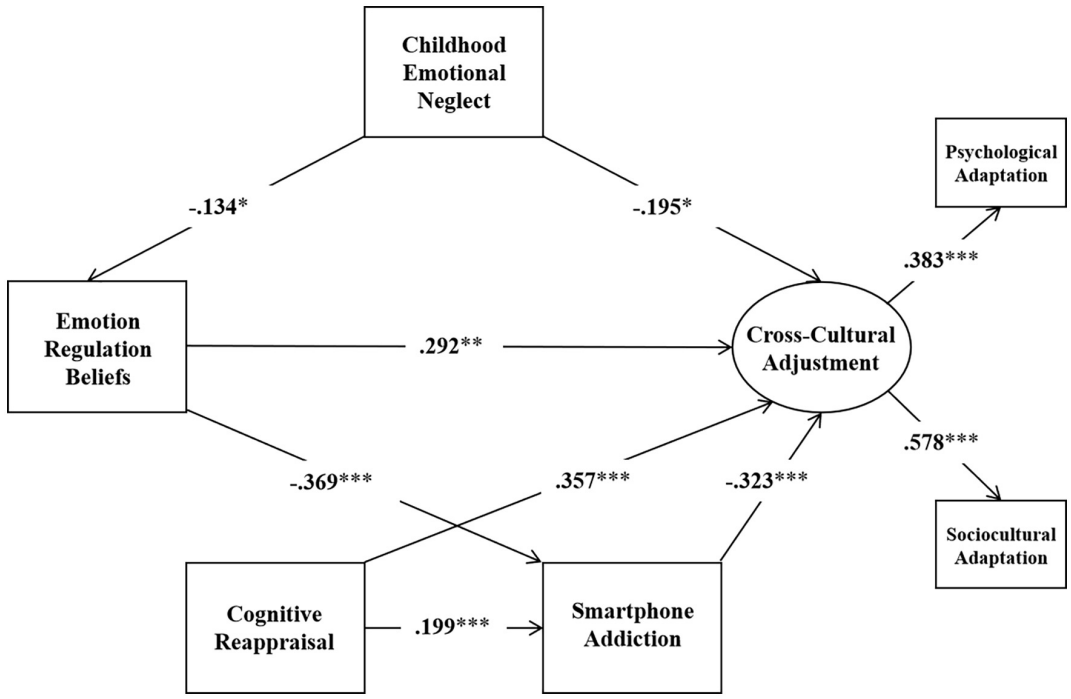

FIGURE 4
Model 4. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

through smartphone addiction with a mediated effect size of −0.064 ($p < 0.05$, 95% confidence interval [−0.130, −0.027]); emotion regulation beliefs had a significant indirect effect on cross-cultural adjustment through smartphone addiction with a mediated effect size of 0.119 ($p < 0.05$, 95% confidence interval [0.056,0.205]); there was no significant indirect effect of childhood emotional neglect on cross-cultural adjustment through emotion regulation beliefs, with a mediated effect of −0.039 ($p > 0.05$, 95% confidence interval [−0.112, −0.005]); childhood emotional neglect affects smartphone addiction through emotion regulation beliefs, and there was no significant indirect effect of childhood emotional neglect on cross-cultural adjustment, the mediating effect size was −0.016 ($p > 0.05$, 95% confidence interval [−0.041, −0.004]).

Discussion

This study examined the relationship between childhood emotional neglect, emotion regulation beliefs, emotional regulation strategies, smartphone addiction, and cross-cultural adjustment in a structural equation model. The results support the social cognitive theory that childhood emotional neglect has a significant negative effect on the cross-cultural adjustment and smartphone addiction through emotion regulation beliefs. Furthermore, two emotional regulation strategies demonstrated different patterns in the model. Emotion regulation beliefs affect smartphone addiction through the mediating role of expression suppression, and expression suppression has no significant effect on cross-cultural adjustment. On the contrast, emotion regulation beliefs have no significant effect on cognitive reappraisal, and cognitive reappraisal affects cross-cultural adjustment through the mediating role of smartphone addiction.

Childhood emotional neglect had a significant negative effect on both emotion regulation beliefs and cross-cultural adjustment, and emotion regulation beliefs had a significant positive effect on cross-cultural adjustment. Our findings fit with the social cognitive theory that early family environment influences individual cognition and behavior, and that cognition in turn influences individual behavior and adaptation to the environment. Social cognitive theory emphasizes that behavioral issues arises from irrational cognition which learned from earlier experiences, and that irrational cognition can affect an individual's psychological wellbeing. An individual's cognitive style is an important factor that influences social adaptation. According to learned helplessness research, individuals form certain beliefs from previous experiences (Seligman and Maier, 1967). Beliefs are related to attribution theory and learned helplessness (Dweck, 1975), and the way individuals attribute in childhood predicts behavior after experiencing frustration. When children attribute emotional neglect to uncontrollable factors, they experience feelings of helplessness and tend to believe that emotions are unregulated, which can have a

TABLE 3 Bootstrap-based specific mediation test analysis.

Model	Path	Standardized indirect effects	95% Confidence interval		*P*-value
			Lower limit	Upper limit	
Model 3	Emotion regulation beliefs → Smartphone addiction → Cross-cultural adjustment	0.048	0.006	0.114	0.080
	Childhood emotional neglect → Emotion regulation beliefs → Cross-cultural adjustment	−0.067	−0.136	−0.014	0.029
	Emotion regulation beliefs → Expression suppression → Smartphone addiction → Cross-cultural adjustment	0.016	0.003	0.037	0.055
	Emotion regulation beliefs → Expression suppression → Smartphone addiction	−0.091	−0.143	−0.053	0.000
Model 4	Cognitive reappraisal → Smartphone addiction → Cross-cultural adjustment	−0.064	−0.130	−0.027	0.009
	Emotion regulation beliefs → Smartphone addiction → Cross-cultural adjustment	0.119	0.056	0.205	0.001
	Childhood emotional neglect → Emotion regulation beliefs → Cross-cultural adjustment	−0.039	−0.112	−0.005	0.107
	Childhood emotional neglect → Emotion regulation beliefs → Smartphone addiction → Cross-cultural adjustment	−0.016	−0.041	−0.004	0.069

negative impact on their future development (Dweck and Reppucci, 1973; Diener and Dweck, 1978). However, because of the inconsistent results of this pathway in the two model mediation tests, it cannot be concluded with certainty for the first hypothesis for the time being. Whether emotion regulation beliefs play a mediating role between childhood emotional neglect and cross-cultural adjustment, which will need to be further verified in future studies.

We found that the second hypothesis was partially supported; emotion regulation beliefs had a significant negative effect on both expression suppression and smartphone addiction, and expression suppression played a mediating role between emotion regulation beliefs and smartphone addiction. More specifically, individuals that endorse emotions cannot be regulated tend to use more expression suppression strategy and exposed themselves in a higher risk of smartphone addiction. This result is in line with some previous studies in which they pointed out that negative beliefs were a marker of addictive behavior (Spada et al., 2013; Hamonniere and Varescon, 2018). It is found that there is a positive association between negative beliefs about anxiety and problematic internet use (Marci et al., 2021), and that higher use of expression suppression by individuals significantly and positively predicts risk of smartphone addiction (Rozgonjuk and Elhai, 2021). As individuals tend to believe that (Mauss and Tamir, 2014), and thus tend to choose to suppress their emotional expression, while expression suppression leads to a decrease in positive emotional experiences (Brans et al., 2013). Smartphone applications provide a possible channel for these individuals to avoid emotional expression and obtain some entertaining experiences to improve their emotions.

Previous studies tend to suggest that emotion regulation beliefs predict increased use of cognitive reappraisals (De Castella et al., 2013), but our findings show no significant effect of emotion regulation beliefs on the cognitive reappraisal. This may be because individuals need to determine which emotion regulation strategy to use based on the available cognitive resources (Urry and Gross, 2010). If individuals endorse that they cannot use an emotion regulation strategy effectively (Gross, 2015), this may lead to an emotional regulation strategy outside of the "cognitive resource pool" being irrelevant to emotion regulation beliefs. This theory was also supported by Suri et al. (2015) experiment which noted that even though participants learned about using cognitive reappraisal, they often did not actively try to use this strategy, when individuals perceive that using cognitive reappraisal is difficult or that the costs of using cognitive reappraisal already outweigh the benefits it brings, then individuals do not choose to use cognitive reappraisals, even if they tend to believe that emotions can be regulated.

When we look at cross-cultural adjustment as one latent factor composed by both types of adaptation, no statistically significant association was found between expression suppression and cross-cultural adjustment, so the third hypothesis was not supported. In the current study, a two-factor correlation analysis found that expression suppression was significantly negatively correlated with psychological adaptation and insignificantly correlated with sociocultural adaptation, which is consistent with some of the previous studies conducted on Chinese populations (Soto et al., 2011; English and John, 2013; Zhao and Zhao, 2015). However, other research findings on the effects of expressive suppression have not reached

the same conclusion, with scholars suggesting that expressive suppression may play a relatively positive function in collectivist cultures (Wei et al., 2013). As human societal values change from collectivism to individualism, individualistic values do not necessarily have positive consequences when they meet with Eastern cultural contexts (Wu et al., 2018). Thus, we suggest that cultural values may be a potential moderating variable in the relationship between expression inhibition and cross-cultural adaptation outcomes (Butler et al., 2007; Cheung and Park, 2010).

The data suggest that cognitive reappraisal has a significant positive effect on cross-cultural adjustment and smartphone addiction, smartphone addiction mediates between cognitive reappraisal and cross-cultural adjustment, and expression suppression has no significant effect on cross-cultural adjustment, so the fourth hypothesis was partially supported. Consistent with previous studies, frequent use of cognitive reappraisal is associated with higher cross-cultural adjustment, and cognitive reappraisal significantly reduces the risk of mental health problems in international students and promotes individual socio-cultural adjustment (Xv et al., 2022). In contrast to previous studies (Zhang and Jiang, 2017), we found that the more individuals tended to use cognitive reappraisals, the higher the level of smartphone addiction. This may be because cognitive reappraisal is not adaptive in all situations, and it is subject to situational variability and differences in individual coping preferences (Zhu et al., 2007; Haines et al., 2016). The cognitive reappraisal may rationalize the problematic smartphone use, leading to an increased risk of smartphone addiction and thus affecting individuals' cross-cultural adjustment (Xie et al., 2019).

The results of the current study showed that 87.1% of Chinese students in Belarus are at high risk of mental health problems. The more international students tend to disbelieve that emotions can be regulated, the higher chance they were at the risk of smartphone addiction, lower levels of psychological adaptation and sociocultural adaptation. Positive emotion regulation beliefs among international students may help reduce problematic smartphone use and improve cross-cultural adjustment. This significant link from emotion regulation beliefs to cross-cultural adjustment through smartphone addiction could shed light on future prevention, and intervention for educators and policymakers. Specifically, to address the possibility that emotion can be regulated and education of useful regulating strategy could be of help. Further, to help international students build healthy connections with locals and to provide psychological support are crucial to preventing smartphone addiction and facilitating cross-cultural adjustment for international students.

There also are some shortcomings in this study. First, we used a cross-sectional research method that does not allow for causal inference and cannot exclude the possible effects of other additional variables; future research could combine experimental methods and longitudinal methods, to further explore the relationship between childhood maltreatment, emotion regulation, smartphone addiction, and cross-cultural adjustment. Second, we used a self-report survey to assess participants' experiences of childhood emotional neglect, therefore were unable to accurately assess the type and extent of maltreatment experienced by participants during childhood; in the future, an observer reporting method could be used to further examine the relationship between childhood maltreatment and individual psychological health in adulthood. Again, this study only discusses the role of childhood emotional neglect, and future research could explore the effects of childhood physical maltreatment and neglect, emotional maltreatment, and sexual abuse on individuals' emotion beliefs and cross-cultural adjustment. In addition, we were unable to obtain information on type of the smartphone use as well as the specific duration of use from self-reported smartphone addiction assessments, and therefore could not accurately estimate the degree of smartphone addiction among participants; future research could incorporate complementary tools such as smartphone software to specifically explore the relationship between different smartphone use patterns and cross-cultural adjustment. Finally, current research on emotion beliefs focuses on two basic types of beliefs: beliefs about the controllability of emotions, and beliefs about the usefulness of emotions, but these are not the only types of beliefs about emotions that people can hold (Ben-Artzi et al., 1995). These two emotion beliefs may change when the specific attributes of the emotion, the situation under discussion, are different (Ford and Gross, 2018). In light of this, in the future we can explore the mechanisms by which various emotion beliefs act on individuals' cross-cultural adjustment in different situations, we can also combine experimental manipulation and clinical interventions to elucidate the causal role of different emotion beliefs in clinical treatments (e.g., addictive disorders) (De Castella et al., 2015; Predatu et al., 2020).

Conclusion

As the unstable regional security situation and the wide spread of COVID-19 may negatively affect the cross-cultural adjustment of Chinese students in Belarus, this study constructs a possible model framework to provide a solution for the cross-cultural adjustment of this group. The results of this study indicate that childhood emotional neglect has a significant negative effect on both emotion regulation beliefs and cross-cultural adjustment. Childhood emotional neglect was found associated with cross-cultural adjustment and smartphone addiction through the path from emotion regulation beliefs and emotional regulation strategy expression suppression. The other regulation strategy cognitive reappraisal affects cross-cultural adjustment through the mediation of smartphone addiction.

Researchers are encouraged to further explore the role of different emotional beliefs in relation to emotion regulation strategies, smartphone addiction and cross-cultural adjustment when the specific attributes of the emotion, and the situation under discussion, are different. In summary, this study deepens the understanding of the impact of childhood maltreatment on the long-term development of individuals; it has implications for preventing smartphone addiction and promoting cross-cultural adjustment of international students.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Ethics Committee of the Belarusian State University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

HW and LF contributed to the data analysis. HW and AS contributed to the data interpretation. All authors conceived the assessment, drafted the manuscript, critically revised the manuscript, and approved the final version for publication.

Conflict of interest

LF was employed by Shenzhen Tiantian Brothers Technology Co.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.1009347/full#supplementary-material

References

Arnett, J. J., Žukauskienė, R., and Sugimura, K. (2014). The new life stage of emerging adulthood at ages 18–29 years: Implications for mental health. *Lancet Psychiatry* 1, 569–576. doi: 10.1016/S2215-0366(14)00080-7

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: W H Freeman/Times Books/ Henry Holt & Co.

Ben-Artzi, E., Mikulincer, M., and Glaubman, H. (1995). The multifaceted nature of self-consciousness: Conceptualization, measurement, and consequences. *Imag. Cogn. Pers.* 15, 17–43. doi: 10.2190/AV07-Y0K1-8D71-FBAA

Bender, M., van Osch, Y., Sleegers, W., and Ye, M. (2019). Social support benefits psychological adaptation of international students: Evidence from a meta-analysis. *J. Cross-Cult. Psychol.* 50, 827–847. doi: 10.1177/0022022119861151

Bernstein, D., Fink, L., and Bernstein, D. P. (1998). Childhood trauma questionnaire: A retrospective self-report manual. *Add. Behav.* 23, 855–868. doi: 10.1016/S0306-4603(98)00072-0

Brans, K., Koval, P., Verduyn, P., Lim, Y. L., and Kuppens, P. (2013). The regulation of negative and positive affect in daily life. *Emotion* 13, 926–939. doi: 10.1037/a0032400

Butler, E. A., Lee, T. L., and Gross, J. J. (2007). Emotion regulation and culture: Are the social consequences of emotion suppression culture-specific? *Emotion* 7, 30–48. doi: 10.1037/1528-3542.7.1.30

Byrne, B. M. (1998). *Structural equation modeling with LISREL, PRELIS, and SIMPLIS: Basic concepts, applications, and programming*. Hillsdale, NJ: Lawrence Erlbaum Associates Publishers.

Cheung, R. Y., and Park, I. J. (2010). Anger suppression, interdependent self-construal, and depression among Asian American and European American college students. *Cultur. Divers. Ethnic. Minor. Psychol.* 16, 517–525. doi: 10.1037/a0020655

Cohen, J. R., Menon, S. V., Shorey, R. C., Le, V. D., and Temple, J. R. (2017). The distal consequences of physical and emotional neglect in emerging adults: A person-centered, multi-wave, longitudinal study. *Child Abuse Neglect* 63, 151–161. doi: 10.1016/j.chiabu.2016.11.030

De Castella, K., Goldin, P., Jazaieri, H., Heimberg, R. G., Dweck, C. S., and Gross, J. J. (2015). Emotion beliefs and cognitive behavioural therapy for social anxiety disorder. *Cogn. Behav. Ther.* 44, 128–141. doi: 10.1080/16506073.2014.974665

De Castella, K., Goldin, P., Jazaieri, H., Ziv, M., Dweck, C. S., and Gross, J. J. (2013). Beliefs about emotion: Links to emotion regulation, well-being, and psychological distress. *Basic Appl. Soc. Psychol.* 35, 497–505. doi: 10.1080/01973533.2013.840632

De Castella, K., Goldin, P., Jazaieri, H., Ziv, M., Heimberg, R. G., and Gross, J. J. (2014). Emotion beliefs in social anxiety disorder: Associations with stress, anxiety, and well-being. *Austr. J. Psychol.* 66, 139–148. doi: 10.1111/ajpy.12053

Diener, C. I., and Dweck, C. S. (1978). An analysis of learned helplessness: Continuous changes in performance, strategy, and achievement cognitions following failure. *J. Pers. Soc. Psychol.* 36, 451–462. doi: 10.1037/0022-3514.36.5.451

Dweck, C. S. (1975). The role of expectations and attributions in the alleviation of learned helplessness. *J. Pers. Soc. Psychol.* 31, 674–685. doi: 10.1037/h0077149

Dweck, C. S., and Reppucci, N. D. (1973). Learned helplessness and reinforcement responsibility in children. *J. Pers. Soc. Psychol.* 25, 109–116. doi: 10.1037/h0034248

Elhai, J. D., Dvorak, R. D., Levine, J. C., and Hall, B. J. (2017). Problematic smartphone use: A conceptual overview and systematic review of relations with anxiety and depression psychopathology. *J. Affect. Disord.* 207, 251–259. doi: 10.1016/j.jad.2016.08.030

English, T., and John, O. P. (2013). Understanding the social effects of emotion regulation: The mediating role of authenticity for individual differences in suppression. *Emotion* 13, 314–329. doi: 10.1037/a0029847

Ford, B. Q., and Gross, J. J. (2018). Emotion regulation: Why beliefs matter. *Can. Psychol.* 59, 1–14. doi: 10.1037/cap0000142

Ford, B. Q., Feinberg, M., Lam, P., Mauss, I. B., and John, O. P. (2019). Using reappraisal to regulate negative emotion after the 2016 US Presidential election: Does emotion regulation trump political action? *J. Pers. Soc. Psychol.* 117, 998–1015. doi: 10.1037/pspp0000200

Ford, B. Q., Lwi, S. J., Gentzler, A. L., Hankin, B., and Mauss, I. B. (2018). The cost of believing emotions are uncontrollable: Youths' beliefs about emotion predict emotion regulation and depressive symptoms. *J. Exp. Psychol. Gen.* 147, 1170–1190. doi: 10.1037/xge0000396

Fortes, A. B., Broilo, P. L., and Lisboa, C. S. D. M. (2021). Smartphone use and psychological well-being: The moderating role of emotion regulation. *Trends Psychol.* 29, 189–203. doi: 10.1007/s43076-020-00051-1

Frodl, T., Reinhold, E., Koutsouleris, N., Reiser, M., and Meisenzahl, E. M. (2010). Interaction of childhood stress with hippocampus and prefrontal cortex volume reduction in major depression. *J. Psychiatr. Res.* 44, 799–807. doi: 10.1016/j.jpsychires.2010.01.006

Gilbert, R., Widom, C. S., Browne, K., Fergusson, D., Webb, E., and Janson, S. (2009). Burden and consequences of child maltreatment in high-income countries. *Lancet* 373, 68–81. doi: 10.1016/S0140-6736(08)61706-7

Goldberg, D. P. (1978). *Manual of the General Health Questionnaire*. Windsor: NFER Publishing Company.

Gross, J. J. (1998). Antecedent-and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. *J. Pers. Soc. Psychol.* 74, 224–237. doi: 10.1037/0022-3514.74.1.224

Gross, J. J. (2015). Emotion regulation: Current status and future prospects. *Psychol. Inq.* 26, 1–26. doi: 10.1080/1047840X.2014.940781

Gross, J. J., and John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *J. Pers. Soc. Psychol.* 85, 348–362. doi: 10.1037/0022-3514.85.2.348

Gulbro, R. D., and Herbig, P. (1999). Cultural differences encountered by firms when negotiating internationally. *Indus. Manage. Data Syst.* 99, 47–53. doi: 10.1108/02635579910261059

Haines, S. J., Gleeson, J., Kuppens, P., Hollenstein, T., Ciarrochi, J., Labuschagne, I., et al. (2016). The wisdom to know the difference: Strategy-situation fit in emotion regulation in daily life is associated with well-being. *Psychol. Sci.* 27, 1651–1659. doi: 10.1177/0956797616669086

Hamonniere, T., and Varescon, I. (2018). Metacognitive beliefs in addictive behaviours: A systematic review. *Add. Behav.* 85, 51–63. doi: 10.1016/j.addbeh.2018.05.018

Hu, L. T., and Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equ. Model.* 6, 1–55. doi: 10.1080/10705519909540118

Hu, S., Liu, H., Zhang, S., and Wang, G. (2020). Proactive personality and cross-cultural adjustment: Roles of social media usage and cultural intelligence. *Int. J. Intercult. Relations* 74, 42–57. doi: 10.1016/j.ijintrel.2019.10.002

Jain, S. C. (ed.) (2006). *Emerging economies and the transformation of international business: Brazil, Russia, India and China (BRICs)*. Cheltenham, UK: Edward Elgar Publishing. doi: 10.4337/9781847202987

Ju, C. E. (2011). Intercultural adaptation to Russia of students from Asia, Africa, Latin America and the Middle East . *RUDN J. Psychol. Pedag.* 3, 6–11.

Kim, S. E., Kim, J. W., and Jee, Y. S. (2015). Relationship between smartphone addiction and physical activity in Chinese international students in Korea. *J. Behav. Add.* 4, 200–205. doi: 10.1556/2006.4.2015.028

Konstantinov, V., Gritsenko, V., Reznik, A., and Isralowitz, R. (2022). The impact of covid-19 on health and well-being: Foreign medical students in Eastern Europe. *Soc. Sci.* 11:393. doi: 10.3390/socsci11090393

Kurapov, A., Pavlenko, V., Drozdov, A., Bezliudna, V., Reznik, A., and Isralowitz, R. (2022). Toward an understanding of the Russian-Ukrainian war impact on university students and personnel. *J. Loss Trauma* 27, 1–8. doi: 10.1080/15325024.2022.2084838

Leung, L. (2008). Linking psychological attributes to addiction and improper use of the mobile phone among adolescents in Hong Kong. *J. Child. Media* 2, 93–113. doi: 10.1080/17482790802078565

Liu, S. S., and Ling, W. Q. (2009). Multiple mediation models and their applications. *Psychol. Sci.* 32, 433–435,407.

MacCallum, R. C., Browne, M. W., and Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychol. Methods* 1, 130–149. doi: 10.1037/1082-989X.1.2.130

Maheu, F. S., Dozier, M., Guyer, A. E., Mandell, D., Peloso, E., Poeth, K., et al. (2010). A preliminary study of medial temporal lobe function in youths with a history of caregiver deprivation and emotional neglect. *Cogn. Affect. Behav. Neurosci.* 10, 34–49. doi: 10.3758/CABN.10.1.34

Marci, T., Marino, C., Sacchi, C., Lan, X., and Spada, M. M. (2021). Problematic Internet Use in early adolescence: The role of attachment and negative beliefs about worry. *J. Behav. Add.* 10, 194–200. doi: 10.1556/2006.2021.00001

Matsumoto, D., Yoo, S. H., and LeRoux, J. A. (2007). Emotion and intercultural adjustment. *Handb. Appl. Linguistics* 7, 77–97. doi: 10.1515/9783110198584.1.77

Mauss, I. B., and Tamir, M. (2014). *Emotion goals: How their content, structure, and operation shape emotion regulation*. New York: The Guilford Press.

Ministry of Education of the Republic of Belarus (2022). *Three decades of Belarusian-Chinese relations*. Available online at: https://edu.gov.by/by-be/news/tri-desyatiletiya-belorusskokitayskikh-otnosheniy/?sphrase_id=262641 (accessed on April 15, 2022).

Ministry of Science and Higher Education of the Russian Federation (2022). *Higher education*. Available online at: https://minobrnauki.gov.ru/action/stat/highed/ (accessed on April 15, 2022).

Moe.gov.cn (2022). *Statistics of 2019 Study Abroad - Government Portal of the Ministry of Education of the People's Republic of China*. Available online at: http://www.moe.gov.cn/jyb_xwfb/gzdt_gzdt/s5987/202012/t20201214_505447.html (accessed on April 15, 2022)

Müller, L. E., Bertsch, K., Bülau, K., Herpertz, S. C., and Buchheim, A. (2019). Emotional neglect in childhood shapes social dysfunctioning in adults by influencing the oxytocin and the attachment system: Results from a population-based study. *Int. J. Psychophysiol.* 136, 73–80. doi: 10.1016/j.ijpsycho.2018.05.011

Popescu, M. L., Drumm, R., Dewan, S., and Rusu, C. (2010). Childhood victimization and its impact on coping behaviors for victims of intimate partner violence. *J. Fam. Viol.* 25, 575–585. doi: 10.1007/s10896-010-9317-5

Predatu, R., David, D. O., and Maffei, A. (2020). Beliefs about emotions, negative meta-emotions, and perceived emotional control during an emotionally salient situation in individuals with emotional disorders. *Cogn. Ther. Res.* 44, 287–299. doi: 10.1007/s10608-019-10064-5

Reuters (2022). *FEATURE-Foreign students fleeing Ukraine, battle racism, extortion*. Available online at: https://www.reuters.com/article/ukraine-discrimination-students-idAFL8N2V48CH (accessed April 15, 2022).

Romero, C., Master, A., Paunesku, D., Dweck, C. S., and Gross, J. J. (2014). Academic and emotional functioning in middle school: The role of implicit theories. *Emotion* 14, 227–234. doi: 10.1037/a0035490

Rozgonjuk, D., and Elhai, J. D. (2021). Emotion regulation in relation to smartphone use: Process smartphone use mediates the association between expressive suppression and problematic smartphone use. *Curr. Psychol.* 40, 3246–3255. doi: 10.1007/s12144-019-00271-4

Rozgonjuk, D., Levine, J. C., Hall, B. J., and Elhai, J. D. (2018). The association between problematic smartphone use, depression and anxiety symptom severity, and objectively measured smartphone use over one week. *Comp. Hum. Behav.* 87, 10–17. doi: 10.1016/j.chb.2018.05.019

Salokangas, R. K., Schultze-Lutter, F., Schmidt, S. J., Pesonen, H., Luutonen, S., Patterson, P., et al. (2019). Childhood physical abuse and emotional neglect are specifically associated with adult mental disorders. *J. Mental Health* 29, 1–9. doi: 10.1080/09638237.2018.1521940

Schroder, H. S., Dawood, S., Yalch, M. M., Donnellan, M. B., and Moser, J. S. (2015). The role of implicit theories in psychological health symptoms, emotion regulation, and hypothetical treatment choices in college students. *Cogn. Ther. Res.* 39, 120–139. doi: 10.1007/s10608-014-9652-6

Searle, W., and Ward, C. (1990). The prediction of psychological and sociocultural adjustment during cross-cultural transitions. *Int. J. Intercult. Relations* 14, 449–464. doi: 10.1016/0147-1767(90)90030-Z

Seligman, M. E., and Maier, S. F. (1967). Failure to escape traumatic shock. *J. Experipsychol. Psychol.* 74, 1–9. doi: 10.1037/h0024514

Shi, J. (2019). *Study on the Status Quo of Intercultural Psychological Adaptation of Chinese Students in Kyrgyzstan*. (Ph.D.thesis). China: Xinjiang Normal University.

Soto, J. A., Perez, C. R., Kim, Y. H., Lee, E. A., and Minnick, M. R. (2011). Is expressive suppression always associated with poorer psychological functioning?A cross-cultural comparison between European Americans and Hong Kong Chinese. *Emotion* 11, 1450–1455. doi: 10.1037/a0023340

Spada, M. M., and Caselli, G. (2017). The metacognitions about online gaming scale: Development and psychometric properties. *Add. Behav.* 64, 281–286. doi: 10.1016/j.addbeh.2015.07.007

Spada, M. M., Caselli, G., and Wells, A. (2013). A triphasic metacognitive formulation of problem drinking. *Clin. Psychol. Psychother.* 20, 494–500. doi: 10.1002/cpp.1791

Stoltenborgh, M., Bakermans-Kranenburg, M. J., Alink, L. R., and van IJzendoorn, M. H. (2015). The prevalence of child maltreatment across the globe: Review of a series of meta-analyses. *Child Abuse Rev.* 24, 37–50. doi: 10.1002/car.2353

Sun, Y., and Nolan, C. (2021). Emotion regulation strategies and stress in Irish college students and Chinese international college students in Ireland. *J. Int. Students* 11, 853–873. doi: 10.32674/jis.v11i4.2516

Sun, Y., Bo, S. Y., and Lv, J. J. (2020). Brain network analysis of cognitive reappraisal and expressive suppression strategies: Evidence from EEG and ERP. *Acta Psychol. Sin.* 52, 12–25. doi: 10.3724/SP.J.1041.2020.00012

Suri, G., Whittaker, K., and Gross, J. J. (2015). Launching reappraisal: It's less common than you might think. *Emotion* 15, 73–77. doi: 10.1037/emo0000011

Tamir, M., John, O. P., Srivastava, S., and Gross, J. J. (2007). Implicit theories of emotion: Affective and social outcomes across a major life transition. *J. Pers. Soc. Psychol.* 92, 731–744. doi: 10.1037/0022-3514.92.4.731

Tao, Y. (2012). *The Intercultural Adjustment of Chinese Interns in The United States:a case of disney international program participants in orlando*. (Ph.D.thesis). China: Shanghai International Studies University.

Trumello, C., Babore, A., Candelori, C., Morelli, M., and Bianchi, D. (2018). Relationship with parents, emotion regulation, and callous-unemotional traits in adolescents'internet addiction. *BioMed Res. Int.* 2018:7914261. doi: 10.1155/2018/7914261

Tu, Y. T., Lin, S. Y., and Chang, Y. Y. (2011). A cross-cultural comparison by individualism/collectivism among Brazil, Russia, India and China. *Int. Bus. Res.* 4, 175–182. doi: 10.5539/ibr.v4n2p175

Urry, H. L., and Gross, J. J. (2010). Emotion regulation in older age. *Curr. Direct. Psychol. Sci.* 19, 352–357. doi: 10.1177/0963721410388395

Veilleux, J. C., Chamberlain, K. D., Baker, D. E., and Warner, E. A. (2021). Disentangling beliefs about emotions from emotion schemas. *J. Clin. Psychol.* 77, 1068–1089. doi: 10.1002/jclp.23098

Veilleux, J. C., Salomaa, A. C., Shaver, J. A., Zielinski, M. J., and Pollert, G. A. (2015). Multidimensional assessment of beliefs about emotion:Development and validation of the emotion and regulation beliefs scale. *Assessment* 22, 86–100. doi: 10.1177/1073191114534883

Wang, K. T., Heppner, P. P., Wang, L., and Zhu, F. (2015). Cultural intelligence trajectories in new international students: Implications for the development of cross-cultural competence. *Int. Perspect. Psychol.* 4, 51–65. doi: 10.1037/ipp0000027

Wang, L., Lu, Y. P., and Li, Z. Q. (2007). Test of Emotion Regulation Scale in adolescents. *Chin. J. Clin. Psychol.* 15, 236–238.

Wang, W. J. (2016). *The Relationship between Implicit Beliefs of Emotion and Emotion, Emotion Regulation: Behavior and Physical Evidence*. (Ph.D.thesis). Yinchuan, China: Ningxia University.

Wang, Y. W., Xiang, J. M., Yang, K. R., Yang, Z. H., and Wu, C. X. (2019). Influence of childhood maltreatment on adult psychology and social behavior. *Chin. J. School Doctor* 33, 738–739.

Ward, C., and Kennedy, A. (1992). Locus of control, mood disturbance, and social difficulty during cross-cultural transitions. *Int. J. Intercult. Relations* 16, 175–194. doi: 10.1016/0147-1767(92)90017-O

Ward, C., and Kennedy, A. (1994). Acculturation strategies, psychological adjustment, and sociocultural competence during cross-cultural transitions. *Int. J. Intercult. Relations* 18, 329–343. doi: 10.1016/0147-1767(94)90036-1

Ward, C., and Kennedy, A. (1999). The measurement of sociocultural adaptation. *Int. J. Intercult. Relations* 23, 659–677. doi: 10.1016/S0147-1767(99)00014-0

Ward, C., and Rana-Deuba, A. (1999). Acculturation and adaptation revisited. *J. Cross-Cult. Psychol.* 30, 422–442. doi: 10.1177/0022022199030004003

Waters, S. F., and Thompson, R. A. (2014). Children's perceptions of the effectiveness of strategies for regulating anger and sadness. *Int. J. Behav. Develop.* 38, 174–181. doi: 10.1177/0165025413515410

Wei, M., Su, J. C., Carrera, S., Lin, S. P., and Yi, F. (2013). Suppression and interpersonal harmony: A cross-cultural comparison between Chinese and European Americans. *J. Counsel. Psychol.* 60, 625–633. doi: 10.1037/a0033413

Wheaton, B., Muthen, B., Alwin, D. F., and Summers, G. F. (1977). Assessing reliability and stability in panel models. *Sociol. Methodol.* 8, 84–136. doi: 10.2307/270754

Womersley, J. S., Hemmings, S. M. J., Ziegler, C., Gutridge, A., Ahmed-Leitao, F., Rosenstein, D., et al. (2020). Childhood emotional neglect and oxytocin receptor variants: Association with limbic brain volumes. *World J. Biol. Psychiatry* 21, 513–528. doi: 10.1080/15622975.2019.1584331

Wu, M. S., Zhou, C., Chen, H., Cai, H., and Sundararajan, L. (2018). Cultural value mismatch in urbanizing China: A large-scale analysis of collectivism and happiness based on social media and nationwide survey. *Int. J. Psychol.* 53, 54–63. doi: 10.1002/ijop.12523

Wu, Q., Luo, J., Bai, J., Hou, M., and Li, X. (2019). Effect of security on mobile addiction: Mediating role of actual social avoidance. *Psychol. Dev. Educ.* 35, 589–596.

Xie, L. L., Ji, Y., Li, C. Y., Hou, Z. H., and Liu, Y. H. (2019). The status of "phubbing" and its relationship with social adjustment in college students. *China J. Health Psychol.* 27, 256–260.

Xiong, J., Zhou, Z. K., Chen, W., You, Z. Q., and Zhai, Z. Y. (2012). Development of the Mobile Phone Addiction Tendency Scale for College Students. *Chin. Psychol. Health J.* 26, 222–225. doi: 10.1037/t74211-000

Xv, Y. Y., Zhang, X. Y., and Yang, J. (2022). Mediating role of emotional regulation strategy in the influence of social support on psychological health of overseas students in China during COVID-19 epidemic. *China J. Health Psychol.* 30, 452–457.

Yang, T. Z., Huang, L., and Wu, Z. Y. (2003). The application of Chinese health questionnaire for psychological disorder screening in community settings in mainland China. *Chin. J. Epidemiol.* 24, 769–773.

Ye, B. J., Fang, X. T., Yang, Q., Zheng, Q., Liu, L. L., and Gou, S. Y. (2017). The effects of difficulties in emotional regulation on college students' mobile phone addiction: The chain mediating effect of facial negative physical self and social avoidance and distress. *Psychol. Dev. Educ.* 33, 249–256.

Young, J. E., Klosko, J. S., and Weishaar, M. E. (2003). *Schema therapy*. New York: Guilford, 254.

Yu, G. L., Li, S., and Zhao, F. Q. (2020). Childhood maltreatment and prosocial behavior among Chinese adolescents:Roles of empathy and gratitude. *Child Abuse Neglect* 101:104319. doi: 10.1016/j.chiabu.2019.104319

Zhang, J. Z., and Jiang, Y. (2017). Effect of college students" emotion regulation strategies on interpersonal disturbances and mobile phone addiction. *Modern Prevent. Med.* 44, 3356–3359.

Zhang, L. L. (2018). *The Chinese Translation and Application of the Emotion and Regulation Beliefs Scale for Nursing Students*. (Ph.D.thesis). China: Jinzhou Medical University.

Zhang, M. (2011). Reliability and validity of the Chinese version of CTQ-SF. *Chin. J. Pub. Health* 27, 669–670.

Zhao, X., Zhang, B. R., Zhang, P., Pan, L., and Zhou, R. L. (2015). Reliability and validity of emotion regulation questionnaire in middle school students. *Chin. J. Clin. Psychol.* 23, 22–25.

Zhao, Y., and Zhao, G. (2015). Emotion regulation and depressive symptoms: Examining the mediation effects of school connectedness in Chinese late adolescents. *J. Adolesc.* 40, 14–23. doi: 10.1016/j.adolescence.2014.12.009

Zhou, H., and Long, L. (2004). Statistical remedies for common method biases. *Adv. Psychol. Sci.* 12, 942–950.

Zhu, X. Z., Luo, F. S., Yao, S. Q., Randy, P. A., and John, R. Z. A. (2007). Reliability and validity of the cognitive emotion regulation questionnaire—Chinese version. *Chin. J. Clin. Psychol.* 15, 121–124.

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 25 November 2022
DOI 10.3389/fpsyg.2022.1066691

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OPEN ACCESS

EDITED BY
Brais Ruibal-Lista,
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SPECIALTY SECTION
This article was submitted to Personality and Social Psychology, a section of the journal Frontiers in Psychology

RECEIVED 11 October 2022
ACCEPTED 02 November 2022
PUBLISHED 25 November 2022

CITATION
Yi J and Li J (2022) The influence of local government competition on residents' perceptions of social fairness—Evidence from China.
Front. Psychol. 13:1066691.
doi: 10.3389/fpsyg.2022.1066691

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The influence of local government competition on residents' perceptions of social fairness—Evidence from China

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Social fairness has been one of the important issues and pursuits in the course of human history since ancient times, and the promotion of social fairness has become a social consensus. Based on the data from the years 2013, 2015, and 2017 Chinese General Social Survey (CGSS), an ordered probit model was constructed for empirical testing to explore the effect of local government competition on residents' perceptions of social fairness and its internal mechanism. The research results show that: (1) Local government competition expands residents' perceptions of social unfairness. (2) Local government competition increases residents' perceptions of social unfairness through the paths of increasing residents' income disparity, crowding out the supply of basic government public goods, and increasing corruption. (3) Local government competition has a significant negative effect on the perceptions of social fairness of the middle-income as well as the high-income but does not affect the low-income. The inhibitory effect of local government competition on the perceptions of social fairness of residents in urban as well as eastern regions is more significant than that in rural and central and western regions. This study has important practical implications for promoting common prosperity to build a harmonious, fair, and democratic modern welfare state and improving the governance capacity of local governments.

KEYWORDS

residents' perceptions of social fairness, local government competition, income disparity, basic public goods supply, corruption

Introduction

The report of the 19th National Congress of the Communist Party of China pointed out: "fairness and justice are the inherent requirements of socialism and an important governing goal." The central government has paid more and more attention and introduced various social policies to the construction of a socialist country with fairness. However, there are still a series of social inequities while the economy is booming. Since the reform and opening up, China's economy has made great progress. Economic development is not only closely related to the reform policy of modernization but also inseparable from the

government governance system. As a "government-led" country, China has obvious characteristics of government intervention in the economy. Local government competition has contributed to the rapid development of China's economy (Zhou, 2003). The competition of local governments has brought positive effects such as economic growth and efficiency improvement. At the same time, it has also expanded the social unfairness of residents under the influence of the experience of "the negative effects of high welfare" and "the high efficiency of the market system." From the perspective of the top-level political system, Under the pressure of political performance appraisal in the economic championship, local governments adopt informal behaviors to compete to achieve the goal of GDP growth, which leads to many social problems affecting social fairness, such as the gap between the rich and the poor, the lack of government in the field of social welfare, and the corruption of public officials. The perceptions of social fairness are the subjective value experience of residents. The objective behavior of individual residents will be affected by their subjective consciousness. The stronger people's perceptions of social fairness are, the higher the people's perceptions of social trust will be, and the more positive pro-social behavior they will show (Van Prooijen et al., 2006).On the contrary, a low perception of social fairness will increase the group's perceptions of social conflict (Li et al., 2012), leading to a decrease in intergroup trust and a lack of contact or even stimulating social conflicts affecting social stability (Alesina and Eliana, 2002). It is particularly important to clarify the extent of the impact of local government competition on residents' perceptions of social justice and the underlying mechanisms.

Research on residents' perceptions of social fairness has been relatively abundant, mainly focusing on the influencing factors and mechanisms. The current studies on the factors influencing the perceptions of social fairness are economic development (Feng and Su, 2021), income level distribution (Ma and Liu, 2010), anti-corruption (Li and Zhang, 2021), government basic public service supply (Li et al., 2018), and fiscal expenditure structure (Sun and Zhang, 2004), etc. But there are no studies on the influence of local government competition factors on residents' perceptions of social fairness. To address this gap, this paper selects the observation perspective of a local government competition to study its specific effect on the perceptions of residents' social fairness. In addition, in the discussion on the influence mechanism of residents' perceptions of social fairness, sociologists have focused on the theory of structural position and the theory of relative deprivation. The objective social structural position theory holds that objective social inequality is positively related to a subjective perception of social justice, people in higher structural positions have a higher perception of social justice (Weng, 2010). However, this conclusion does not apply to all phenomena regarding the perceptions of social justice. For example, Moting (2009) research showed that some residents with higher class positions react more strongly to social inequality instead. The relative deprivation perceptions theory refutes the structural position theory of social equality. It is believed that the perceptions of social fairness mainly come from the residents' perceptions of relative deprivation through "social comparison." The lower the level of relative deprivation is, the stronger the perceptions of social equality are. Both of these theories can enable us to explore the mechanisms that influence residents' perceptions of social fairness, and greatly deepen people's understanding of social fairness. But they both start from the micro-level of the individual and ignore that the macro-level of the government is also an important subject and one of the influencing factors in achieving social fairness. The behavior of local government plays a significant role in maintaining social fairness, but this assumption is rarely explored.

Therefore, given the above analysis, this paper combines the years from 2013, 2015, and 2017 China General Social Survey (CGSS) micro-data and government-level macro-data set to conduct an empirical test using an ordered probit model to explore the effect of local government competition on residents' perceptions of social fairness and its intrinsic mechanism of action. The results of the study showed that local government competition expands residents' perceptions of social unfairness, mainly through three channels: widening the gap between rich and poor residents, crowding out basic public services such as education, health care, and social security, as well as increasing corruption. In addition, the heterogeneity test found that local government competition has an obvious negative effect on the perceptions of social fairness of middle-income and high-income groups, but has no impact on the perceptions of social fairness of low-income groups. Compared with rural residents and residents in the central and western regions, local government competition has a more significant inhibiting effect on the social justice of urban residents and residents in the eastern region. Once the gap between the rich and the poor and the resident's perceptions of social fairness are formed, it is often difficult to reverse it. The participation of existing vested interests will increase the resistance to governmental reform when the fact or class is solidified, so income distribution should be carried out in the process of economic development. A good social fairness mechanism should be established so that people can share the fruits of economic development. This study has important implications for dealing with the imbalance between economic and social development, the excessive gap between the rich and the poor, and social unfairness, as well as for strengthening the governance capacity of local governments and promoting common prosperity to further build a fair and democratic modern state.

Institutional background, theoretical analysis, and research hypothesis

Institutional background

Local government competition refers to the process in which each local government, based on fiscal decentralization, adopts

corresponding public policies to compete for resources to maximize the interests of each jurisdiction. The forms of participation include tax competition, public goods competition, and institutional competition, manifested as horizontal competition, vertical competition, and scalar competition (Huang and Zhou, 2001). The research on local government competition originated in the West. In terms of public goods competition effects, Tiebout (1956) and Oates (1972) et al. argue that free-moving residents will migrate to jurisdictions which might satisfy them. And local governments will adopt a series of efficient fiscal policies and public goods measures to meet residents' demands to prevent the outflow of residents and capital, thus increasing the public goods supply efficiency of jurisdictional governments. In terms of the economic effects of local government competition, Van Prooijen et al. (2006) argue that local governments compete to improve the business environment through institutional innovation, tax incentives, and other proven administrative initiatives to attract the inflow of other jurisdictional resources to raise fiscal revenues and promote the economic development of their jurisdictions when resources are within limited availability. However, some studies take a negative attitude towards local government competition, Zodrw and Mieszkowski (1986) constructed a model to find that land is not mobile while capital is mobile across jurisdictions, jurisdictional governments will seek to maximize land rents and will compete fiercely for capital taxes. As the number of competing jurisdictions continues to increase capital taxes will race to the bottom eventually leading to too low a level of tax revenue in each jurisdiction, thus causing residents to doubt local government administrative systems and government public. This "destructive local competition" can lead competing local governments into a "prisoner's dilemma" of avoiding business flights from residents and failing to provide sufficient public goods.

Although different from the federal state structure of the developed countries in the West, as long as there are multiple levels of government decentralization in any type of government, there will inevitably be competition between sub-governments for their interests. Competition among local governments also exists in China. During the transition of the domestic economy from a planned economy to a market economy, the central government uses fiscal transfer policies and government performance appraisal systems to control local governments, which in turn assume governmental responsibilities through certain fiscal expenditures and tax revenues, as well as the corresponding independent authority. Local governments play political games with the central government. Meanwhile, local governments develop local economies and stabilize their jurisdictions to obtain more administrative resources and a better institutional environment. At the same time, local governments strengthen their competitiveness through technological innovation and continuous improvement of infrastructure to compete with their counterparts in attracting resources and competing for talent and economic markets. In this process of progressive restructuring, China has developed a pattern of vertical competition among different levels of government and horizontal competition among peer governments. More characteristic of China, as a developing country, economic development has always been a priority. Thus a political environment has been created in which the promotion prospects of local government officials are linked to regional economic performance based on an assessment of the jurisdiction's GDP. The political pressure for promotion internalizes the behavior of local government officials. Each local government official tries to integrate as much as possible the economic and political resources under his or her control and influence to promote the economic growth of the region (Zheng et al., 2005). Under China's highly centralized administrative system of personnel power, officials at the provincial, municipal, county, and township levels of government are in a political promotion or political tournament in which they compete for economic performance and fiscal revenue within their jurisdictions (Zhou, 2004).

Theoretical analysis and research hypothesis

Local government competition, income disparity, and residents' perceptions of social fairness

Local government competition leads to the inequality of residents' income by widening the income gap between urban and rural areas and regional income as well as the intervention in the market. The meaning of fairness is richer, the fairness of power, the fairness of the outcome, the fairness of opportunity, etc. But at this stage, the main discussion is the fairness in the field of distribution, mainly reflected in the income gap between different social classes (Li and Xu, 2021). Changes in income disparity in China are closely related to the historical process of urban–rural social changes and economic policy adjustments brought about by government-led economic growth and market-oriented reforms. The current income disparity among Chinese residents is mainly concentrated between regions and between urban and rural areas (Xie and Zhou, 2014). And the important factors affecting income inequality include the government and the market (Cai and Yue, 2016).

First, local government competition will widen the income gap between urban and rural residents. The "urban–rural dualistic economic structure" began to form as a result of the long-standing "catch-up" strategy and the urban bias of "planned allocation" of resources before the reform. Government officials have incentives for political promotion, and the "political tournament" around local GDP growth directly influences the behavior of local government officials. Under this pattern of local government competition, the government-dominated economic system directly influences changes in the urban–rural income gap through the allocation

of public financial resources and the urban bias of economic policies. The government's mechanism of targeting investments and choices to "high-value, high-income" enterprises and urban areas with good development conditions hinders the efficient allocation of capital, land, and other factors, as well as the "power allocation" that relies on policy protection and resource management. It distorts the way of income sharing and increases income inequality (Chu and Jin, 2013). At the same time, the "profit-seeking" nature of market micro-enterprises makes them reluctant to invest in agriculture and rural areas, resulting in long-term neglect of agricultural and rural development and a significant widening of the urban–rural income gap. Secondly, local government competition can aggravate the income gap between regions (Zhang, 2017). Not all governments in the local government competition system are competitive and rational at the beginning, but a small number of local governments are full of competitive spirit. They are the first to innovate through "institutional competition" to obtain more resources to improve the economy and the welfare of residents in their jurisdictions, which is the beginning of regional economic growth and disparities (Jin, 2017). As the competition continues, other provinces are forced to join the competition passively as the disparity between jurisdictions widens. When a province or municipality becomes a relatively independent body of economic or political interests, which is to their advantage. The local government that wins the competition establishes a cycle of power and economic circulation, using the administrative power and economic advantages it holds to erect barriers to circulation for localist protection as well as regional segmentation and blockade, which in turn increasingly increases economic inequality among regional residents.

The socioeconomic status hypothesis and objective social structure location theory consider economic income disparity as an important factor contributing to the decline in residents' perceptions of social fairness. From an individualistic perspective, socioeconomic status affects an individual's ability to access and control resources, as well as an individual's attribution of fairness in his or her access to resources and distribution outcomes (Tian and An, 2019). The socioeconomic status brought about by the economic income gap also determines a certain degree of the high or low social structural position of the population, with those who have higher socioeconomic status and are in a higher structural position having a higher perception of social fairness (Cheng, 2007). Excessive income disparity leading to a highly unequal income structure can threaten social fairness and directly inhibit the public perceptions of social justice (Ling and Liu, 2018). Excessive income disparity brings a psychological feeling of unfairness to individual residents through subjective perceptions, which ultimately undermines social fairness.

Given the above analysis, this paper proposes research hypothesis H1: Local government competition amplifies the perception of residents' social unfairness by widening the income gap among residents.

Local government competition, government supply of basic public goods, and residents' perceptions of social fairness

The government uses taxpayers' money to provide its public goods but has a monopoly on the supply of public goods. Local governments and administrative officials have to compete as long as residential and capital factors can flow through separate administrative jurisdictions in the country (Ke and Shi, 2000). The Chinese government is economically investment-oriented because of the exceptionally intense competitive dynamics of local governments under the Chinese political and economic system that uses GDP growth as a political promotion assessment mechanism. Local governments tend to distort the structure of government fiscal spending on infrastructure development and public services for the sake of GDP growth (Fu and Zhang, 2007). Education fairness and health care fairness are the starting point and prerequisite for social fairness and justice. The government invests too many financial resources in infrastructure and productive public goods and squeezes out non-productive public service expenditures such as education, medical care, and social security, which are closely related to people's welfare (Zhang and Chen, 2006). The provision of basic public services can, on the one hand, provide more opportunities for the lower class to improve their human capital and, on the other hand, improve the risk-taking ability of all social classes to promote social mobility, thus calming people's perceptions of social unfairness (Zhang and Fu, 2009). The financial shortage of public services *per capita* in China has led to low perceptions of social fairness.

Competition for local government officials in China is fierce (Lou, 2010). The promotion and re-election of local government officials in China do not come primarily from elections but from central government appointments. People in the jurisdiction lack channels to express their needs for public goods through the selection of local government officials. The pyramidal power structure has led to a large number of local government officials in China, which makes it difficult for officials to be promoted and the degree of competition is strong. In addition, to the short tenure of officials, to quickly achieve "performance" and "promotion" within the limited tenure, local government officials tend to pay attention to short-term utility and give up investing in public services (Wang, 2021). Investment in public services is difficult to see the return in the short term before the long-term gain. Thus, the competition among local officials will lead to the government's emphasis on the economy rather than people's livelihoods further aggravating the misalignment of government functions, directly causing the local government's shortage of basic public services and public goods supply (Fu, 2010). In addition, based on the Western public choice school of thought, competition among local governments is expected to lead to more efficient public goods. The basic premise of these theories is that capital and residents will choose different jurisdictions using a "vote with their feet" approach, and the models generally set local government competition in a single institutional setting assuming that market capital or residents are perfectly mobile. However, due

to its particular historical origins, China's household registration system restricts the free movement of residents, preventing them from moving to provinces and cities with better public services. This administrative system, which prevents the free movement of people (Zhang and Zhao, 2017), is fundamentally at odds with the Western public choice school of thought. Some residents who work or live in cities with better public services may not be able to enjoy the welfare policies or suffer unfair treatment because they do not have a local hukou (household registration). The apparent resource asymmetry and differential treatment of power and opportunity in education, health care, and social security benefits can exacerbate residents' perceptions of social unfairness.

Given the above analysis, this paper proposes research hypothesis H2: Local government competition amplifies the perception of social inequity by crowding out essential government public goods.

Local government competition, corruption, and residents' perceptions of social fairness

Local government competition tends to increase the level of political corruption. Based on the principal-agent theory, local governments have a dual fiduciary-agent relationship with the central government and citizens. Due to information asymmetry and fiscal decentralization, local governments have a lot of financial control and discretionary power over local affairs. Local government officials have huge economic and administrative resources that make them face many temptations. Some private sectors or interest groups try to find ways to find rent and entice and bribe local government officials to use their resources and political power to "facilitate and open the back door" for themselves (Pan and Wu, 2019). The powerful position of local governments in China's social structure has led to less oversight and checks and balances, increasing egoistic government officials' adverse selection and opportunistic behavior. The ensuing selfish government officials engage in power and money deals to maximize political rents (Li, 2016). Especially when local governments invest in massive infrastructure construction or large capital investments for GDP competition. Because construction projects or capital investments involve large, complex, and non-standard activities whose quality is difficult to assess. They allow maximum rent-seeking and a large amount of corruption is hidden in the field of infrastructure investment (Yu et al., 2021). A more corrupt official or government will support the government's financial choices in projects that favor rent-seeking such as infrastructure and capital projects. Empirical evidence suggests that bribery of officials with discretionary authority in government contracting and regulatory-related industries is common. Local government competition can lead to an increase in the size of government, which not only makes it more difficult to monitor local governments but also reduces the salary income of local government officials, making them more likely to engage in profit-seeking activities such as administrative "fishing" (Zhou and Tao, 2009). In addition, some officials in backward areas feel hopeless in the competition for promotion in local government, and they will adopt the attitude of "breaking the pot," hoping to use their power to make up for the loss of money and power when they cannot be promoted, which will also lead to corruption (Tang et al., 2013).

Classical fairness theory assumes that people have all the information about their payoffs and rewards and that they can make a fair judgment through rational calculation and comparison (Adams, 1963). People do not have such information, so emotions play a role in judging fairness instead of information, and this emotional dynamics mechanism considers social fairness as a special judgment mechanism. Fairness is the result of individual judgment, and the judicial process is largely influenced by individual intuition and emotion. Thus, it can be seen that residents' real social justice is not entirely based on rationality and calculation to judge whether society is fair or not (Lin, 2001), but often has obvious emotions, intuition, emotions, and other subjective emotional association factors, so we should not ignore such emotional factors in the analysis of the formation mechanism of residents' perceptions of fairness. The impact of corruption on the perceptions of social justice corresponds to the cognitive and emotional dynamics of the formation of the perceptions of social justice. Corruption not only undermines the functioning of the administrative system (Anderson and Tverdova, 2003) but also shakes the socioeconomic foundation (Mauro, 1995). It is a persistent problem in the political system because of its complex and hidden means, and it is often difficult for the general public to know the specific amount, means, and input–output ratio of corruption. However, the massive exposure and in-depth disclosure of corruption information may allow the general public to directly learn about specific cases that are otherwise unknown to them, which gives the public a concrete outlet for their emotions but only a glimpse of the tip of the iceberg. According to the Information Uncertainty Management Model, in situations of information uncertainty, people often try to judge fairness by other means. This is where emotions play a significant role, and information uncertainty is one of the mediating moderators (Kees, 2003). Corruption exacerbates the influence of emotions through uncertain information contexts leading to more pronounced and intuitive perception of social unfairness. While the public can accept wealth or class disparities caused by differences in individual talents and abilities, it is often more difficult to tolerate corruption outside the system, especially when it is a power factor. Studies have shown that the "relationship economy" and official corruption are the main factors contributing to the perceptions of social unfairness (Li, 2006). Because "attribution preference" is more sensitive to people's judgments about social justice, the stronger the perceptions of distributive justice are when people attribute the cause of social inequality to personal factors, and the stronger the perceptions of distributive injustice are when people attribute the cause outward to power and the system.

Given the above analysis, this paper proposes research hypothesis H3: Local government competition amplifies the perception of social inequity by fostering corruption. Given the above analysis.

In short, the central government cedes certain economic and fiscal administrative powers to local governments, establishes a performance appraisal system centered on economic growth, and makes local governments pay attention to economic development through personal incentives such as the selection and promotion of officials. However, in the relative performance assessment of the incentive structure of the Chinese government's governance political tournament model, government officials may deviate from the interests of their constituents according to their interests, or excessive competition among local governments may weaken the market mechanism and lead to chaos and distortion of resource allocation, resulting in an excessive gap between the rich and the poor, lack of social public utilities, and government corruption. This reduces the residents' sense of the social public.

Given the above analysis, this paper proposes research hypothesis H4: Local government competition will amplify residents' sense of social inequity.

Data and methods

Data sources

The individual-level data used in this paper are from the years 2013, 2015, and 2017 China General Social Survey (CGSS). It is a large-scale comprehensive social survey designed and implemented by the National Survey Research Center at Renmin University of China which uses a multi-stage stratified probability proportional sampling and covers 31 provincial administrative units (autonomous regions and municipalities directly under the Central Government, excluding Hong Kong, Macao, and Taiwan) in mainland China, except for the Tibet Autonomous Region. The surveyed content involves many aspects of the respondents, such as background information, marital and family status, work and income, attitude, and behaviors, indicating a strong representativeness and credibility. Economic data at the regional level were obtained from the China Statistical Yearbook. The resident population data at the regional level were obtained from the Statistical Bulletin on National Economic and Social Development released by each province, autonomous region, and municipality directly under the Central Government. Corruption data at the regional level were collected manually from the content of each provincial procuratorate's chief procurator's reports to their corresponding provincial people's congresses in the China Procuratorial Yearbook in previous years. For better analysis, this paper collated the initial data according to the following methods: (1) Samples with missing information were excluded. (2)Samples with incorrect information were excluded. (3) Samples with outliers were excluded. This paper finalized the sample size of 20,075 individuals was added

Variables selection

Explained variable: the residents' perceptions of social fairness. In this paper, we use perceptions of social fairness indicators from the 2013, 2015, and 2017 CGSS.The questionnaire of China General Social Survey asked respondents "In general, do you think the society today is fair?" The results were measured on a five-point Likert scale: Very unfair = 1, relatively unfair = 2, cannot say fair not fair = 3, relatively fair = 4, very fair = 5.

Explanatory variable: local government competition. Local government competition data was from the China Statistical Yearbook and the National Economic and Social Development Statistical Bulletin. Given that the location of the household micro-data selected for this paper can only be located at the provincial level. This paper will be based on the province where the household is located. Following Zhang et al. (2007), the ratio of foreign direct investment at the provincial level to the number of permanent residents in the area is used to measure local government competition.

Mediating variables: income disparity, basic government public goods, and corruption. Corruption data indicators were from China Prosecution Yearbook, Thiel coefficient and government supply of basic public goods data indicators were from China Statistical Yearbook. The income gap indicator uses the Thayer coefficient. The government basic public goods indicator refers to Li et al. (2018) and is measured by the *per capita* social spending in the corresponding area of the respondent. *Per capita*, social spending mainly refers to the total *per capita* investment of local governments in education, health care, social security, and employment. Corruption indicators refer to the existing literature. He et al. (2016), use the number of office crimes filed per 10,000 public officials to measure the degree of corruption in each region.

Control variables: To reduce the possible bias of model estimation caused by omitted variables, the following control variables are introduced in this paper in combination with existing literature. The control variables here were all from the CGSS form2013, 2015, and 2017.These include: (1) gender (Female = 0, Male = 1). (2) Age (Age of respondents). (3) Household registration (Rural = 0, Town = 1), (4) Ethnicity (Other = 0, Han = 1), (5) Education level (1 to 7, the higher the value, the higher the level of education), (6) Political appearance (Other = 0, Party member = 1). (7) Marital status (Other = 0, Married = 1). (8) Health status (1 to 5, the higher the value, the healthier the self-assessment), (9) Self-assessed social status (1 to 10, the higher the value, the higher the self-rated social status), (10) Household income (income is taken as logarithm), (11) Self-assessed family status (1 to 5, the higher the value, the higher the self-rated household economic status; Table 1).

Model settings

We developed an overall model to measure the impact of local government competition on residents' perceptions of social

TABLE 1 Descriptive statistics of main variables.

Variables	Description	Mean	SD	Min	Max
fair	social perceptions of fairness	3.11	1.06	1	5
gov	local government competition	5.24	1.09	2.82	7.02
gap	income gap	0.02	0.05	−0.059	0.15
fuwu	supply of basic public goods	0.38	0.04	0.31	0.48
corrpt	corruption	18.87	7.71	4.62	34.38
gender	gender	0.48	0.50	0	1
age	age	51.04	16.70	18	103
hukou	hukou	0.47	0.50	0	1
nation	ethnicity	0.92	0.27	0	1
edu	education	2.84	1.63	1	14
party	politics face	0.12	0.32	0	1
marry	marriage situation	0.76	0.43	0	1
health	health status	3.49	1.09	1	5
status	self-assessment of social status	4.16	1.68	1	10
income_family	household income	10.68	1.24	1.94	16.12
economy_family	self-assessment of family economic status	2.55	0.75	1	5

fairness. Based on the previous analysis, the following model is developed for empirical analysis:

$$fair_{it} = \alpha 0 + \alpha 1 gov_{it} + \beta \Sigma x_{it} + u_{it} \quad (1)$$

fairit indicates the perceptions of social fairness of the surveyed residents in different provinces *i* and year *t*, govit indicates the degree of local government competition at the provincial level, xit is other control variables, uit is a random disturbance term, and α0,α1 and β are regression coefficients. Since the explained variable perceptions of social fairness is a multinomial ordered choice variable, this paper chooses the ordered probit (Ordered Probit) model for parameter estimation.

To further investigate its specific mechanism of action and verify the mechanistic framework of the theoretical analysis part, the following test steps are designed in this paper: firstly, test the effect of local government competition on residents' subjective perceptions of social fairness according to the equation. (2) Secondly, test the existence of mediating effect from the effect of local government competition on each mediating variable according to the equation. (3) Finally, add both local government competition variables and mediating variables in the regression equation to test the inner mechanism of the effect of local government competition on residents' perceptions of social fairness, as shown in equation (4).

$$fair_{it} = \alpha 0 + \alpha 1 gov_{it} + \beta \Sigma x_{it} + u_{it} \quad (2)$$

$$P = \gamma 0 + \gamma 1 gov_{it} + \gamma \Sigma x_{it} + u_{it} \quad (3)$$

$$fair_{it} = \delta 0 + \delta 1 gov_{it} + \rho P + \delta \Sigma x_{it} + u_{it} \quad (4)$$

In the above equation, *i* and *t* denote province and year, respectively, and P = (p1， p2， p3) denotes the three mediating variables proposed in this paper. Uit is a random disturbance term. The data was then analyzed using statistical software stata16.

Empirical results

Basic regression results

Equation (1) was estimated using an ordered probit model, and the marginal effects of each variable on residents' perceptions of social fairness were examined on this basis. The regression results are shown in Tables 2, 3, respectively.

In Table 2, columns (1), (2), and (3) show the regression results without and with the inclusion of control variables, respectively. The coefficients of local government competition variables are significantly negative, implying that local government competition is not conducive to the enhancement of residents' perceptions of social fairness. The reasons may be caused by the fact that local government competition can widen the gap between the rich and the poor, interfere with the market economy and distort the allocation of financial resources as well as increase corruption. Among the control variables ethnicity, marriage, and household registration have significantly negative coefficients, indicating that ethnic minorities, rural households, and unmarried groups have a stronger perception of social fairness. The regression coefficients of the variables education, self-rated social status, age, and health are significantly positive, which indicates that the more educated, higher self-rated social status, older, and healthier groups have a stronger perception of social justice. The regression coefficients of the variables of household income are significantly negative, which implies that higher absolute household income does not necessarily lead to higher perceptions of social fairness. The coefficient of the self-assessed household economic income status variable is significantly positive, which indicates that the higher the self-assessed household economic income status, the higher the perceptions of social fairness in the households.

In Table 3, the analysis of marginal effects shows that for each unit increase in the local government competition index, the probability of social fairness of the five categories of residents from low to high changes by 0.006, 0.01, 0.002, −0.015% and-0.003%, respectively. That is, local government competition can increase the probability of residents' "very unfair," "relatively unfair,"

TABLE 2 Basic regression results.

Variables	(1)fair	(2)fair	(3)fair
	Oprobit	Oprobit	Oprobit
gov	−0.047***	−0.065***	−0.048***
	(−4.70)	(−5.89)	(−4.22)
gender		0.030	0.032
		(1.38)	(1.44)
nation		−0.109**	−0.106**
		(−2.47)	(−2.36)
edu		0.029***	0.034***
		(3.36)	(3.91)
party		0.054	0.054
		(1.50)	(1.49)
hukou		−0.131***	−0.104***
		(−5.21)	(−3.93)
status		0.110***	0.091***
		(14.95)	(10.81)
marry		−0.082***	−0.071***
		(−3.19)	(−2.68)
age		0.012***	0.011***
		(14.91)	(12.80)
health		0.056***	0.057***
		(4.68)	(4.60)
income_family			−0.073***
			(−5.64)
economy_family			0.133***
			(7.00)
N	20,075	20,075	20,075
R2	0.108	0.219	0.242

***, **, * indicate statistically significant at the 1, 5, and 10% levels, respectively.
t-values in parentheses.

"cannot say fair or not fair," while reducing the probability of "relatively fair" and "very fair." This result suggests that local government competition has a suppressive effect on the increase of residents' subjective social fairness.

Robustness test

Substitution of core explanatory variables

To measure local government competition from other perspectives, referring to Miao et al. (2017), the formula is calculated as follows: a province's economic catch-up level = (highest GDP *per capita* in neighboring provinces/province's GDP *per capita*) × (highest GDP *per capita* in national provinces/province's GDP *per capita*), which is estimated using the probit model according to equation (1). The results are shown in column (1) of Table 4, where the coefficient of the local government competition variable is significantly negative after replacing the measure of local government competition, and the study results remain robust.

TABLE 3 Regression results of marginal effects of the effects of various variables on Perceptions of social fairness.

Variable	Fair = 1	Fair = 2	Fair = 3	Fair = 4	Fair = 5
gov	0.006***	0.010***	0.002***	−0.015***	−0.003***
	(4.19)	(4.23)	(4.10)	(−4.23)	(−4.15)
gender	−0.004	−0.007	−0.001	0.010	0.002
	(−1.44)	(−1.44)	(−1.43)	(1.44)	(1.43)
nation	0.014**	0.023**	0.004**	−0.033**	−0.008**
	(2.36)	(2.36)	(2.34)	(−2.37)	(−2.34)
edu	−0.005***	−0.007***	−0.001***	0.011***	0.002***
	(−3.89)	(−3.91)	(−3.82)	(3.91)	(3.86)
party	−0.007	−0.012	−0.002	0.017	0.004
	(−1.49)	(−1.49)	(−1.49)	(1.49)	(1.49)
hukou	0.014***	0.022***	0.004***	−0.033***	−0.007***
	(3.92)	(3.93)	(3.83)	(−3.94)	(−3.87)
status	−0.012***	−0.019***	−0.003***	0.028***	0.006***
	(−10.26)	(−10.95)	(−9.34)	(10.90)	(9.93)
marry	0.009***	0.015***	0.003***	−0.022***	−0.005***
	(2.67)	(2.68)	(2.65)	(−2.68)	(−2.66)
age	−0.001***	−0.002***	−0.001***	0.003***	0.001***
	(−12.17)	(−12.82)	(−10.28)	(12.99)	(11.09)
health	−0.008***	−0.012***	−0.002***	0.018***	0.004***
	(−4.57)	(−4.61)	(−4.46)	(4.61)	(4.53)
income_	0.010***	0.016***	0.003***	−0.023***	−0.005***
family	(5.60)	(5.65)	(5.33)	(−5.67)	(−5.44)
economy_	−0.018***	−0.028***	−0.005***	0.042***	0.009***
family	(−6.91)	(−7.00)	(−6.46)	(7.01)	(6.75)
N	20,075	20,075	20,075	20,075	20,075

***, **, * indicate statistically significant at the 1, 5, and 10% levels, respectively.
t-values in parentheses.

Assignment method for adjusting the perceptions of social fairness

The variables have been controlled for in the selection of control variables in this paper. However, the subjective social fairness evaluation given by the respondents may not be accurate and true due to factors such as free ride motivation or respect for visitors. Based on this, the evaluation of residents' subjective perceptions of social fairness is reassigned. The specific adjustment rules are as follows: the answers to "very fair," "relatively fair" and "not fair or unfair" are assigned to 1, and the answers to "relatively unfair" and "unfair" are assigned to 0. "This adjustment reduces the problem of data bias caused by subjective reasons such as inconsistent standards. The estimation is then performed using a binary probit model based on the equation (1). The regression results are presented in column (2) in Table 4, and it can be found that the effect of local government competition on residents' subjective perceptions of social fairness does not change essentially after adjusting the assignment method of the perceptions of social fairness. The coefficient of the local government competition variable remains significantly negative, which means that the research finding that local government competition amplifies residents' perceptions of social unfairness is robust.

TABLE 4 Robustness tests.

Variables	(1)fair	(2)fair	(3)fair	(4)fair
	Oprobit	Probit	OLS	Ologit
gov1	−0.019***			
	(2.85)			
gov		−0.040***	−0.046***	−0.081***
		(−2.77)	(−4.20)	(−4.08)
gender	0.028	0.015	0.028	0.059
	(1.26)	(0.55)	(1.35)	(1.55)
nation	−0.152***	−0.072	−0.081**	−0.167**
	(−3.41)	(−1.36)	(−1.99)	(−2.15)
edu	0.031***	0.032***	0.032***	0.059***
	(3.62)	(2.78)	(3.91)	(4.01)
party	0.060	0.007	0.048	0.089
	(1.64)	(0.16)	(1.42)	(1.37)
hukou	−0.112***	−0.102***	−0.096***	−0.176***
	(−4.16)	(−3.10)	(−3.82)	(−3.89)
status	0.093***	0.090***	0.085***	0.158***
	(10.91)	(9.34)	(11.10)	(10.81)
marry	−0.064**	−0.048	−0.062**	−0.116**
	(−2.38)	(−1.47)	(−2.50)	(−2.55)
age	0.011***	0.010***	0.010***	0.019***
	(12.32)	(9.74)	(12.76)	(12.71)
health	0.050***	0.055***	0.055***	0.102***
	(4.03)	(3.83)	(4.82)	(4.78)
income_family	−0.079***	−0.058***	−0.064***	−0.130***
	(−6.06)	(−3.75)	(−5.44)	(−5.75)
economy_	0.132***	0.143***	0.131***	0.244***
family	(6.88)	(6.39)	(7.43)	(7.49)
N	20,075	20,075	20,075	20,075
R2	0.243	0.319	0.314	0.244

***, **, * indicate statistically significant at the 1, 5, and 10% levels, respectively. t-values in parentheses.

Replacement regression method

Robustness tests were conducted using Ordinary Least Squares (OLS) and Ordered Logit (OL) models. The regression results are presented in column (3) and column (4) of Table 4, which show that the regression coefficient of local government competition remains significantly negative. The results are consistent with the regression results of the Oprobit model, which indicates that the finding that local government competition is not conducive to the improvement of residents' perceptions of social fairness is robust.

Mechanisms

Income effect

This paper proposes three mechanisms by which local government competition affects residents' perceptions of social fairness. Firstly, we examine the mechanism of the role of income disparity in local government competition in reducing residents' perceptions of social fairness. The regression coefficient of the local government competition variable in column (2) of Table 5 is significantly positive, indicating that local government competition can widen income disparity. Further, the regression results of both the explanatory variable local government competition and the mediating variable Thayer coefficient in column (3) show that the local government competition variable is significantly negative and significantly reduced compared with the coefficient of the local government competition variable in column (1). In addition, the coefficient of the Thiel coefficient is significantly positive, implying that excessive income disparity increases residents' perceptions of social unfairness. The regression results in columns (1), (2), and (3) show that there is a mediating effect of the Thayer coefficient between local government competition and the perceptions of social fairness, thus forming the inner mechanism of "local government competition → widening the income gap → decreasing the perceptions of social fairness." Local government competition reduces residents' perceptions of social fairness by widening their income gap.

Public service effects

Then, the mechanism of the role of government basic public goods supply in local government competition in reducing the perception of social fairness is examined. The coefficient of local government competition in column (4) of Table 5 is significantly negative, indicating that local government competition can reduce the supply of basic government public goods. Further, column (5) puts both the explanatory variable of local government competition and the mediating variable of government supply of essential public goods. The regression results show that the coefficient of local government competition is significantly negative and decreases significantly compared with the coefficient of local government competition in column (1), and the coefficient of government supply of basic public goods is significantly positive, which means that government supply of basic public services can improve residents' perceptions of social fairness. The regression results in columns (1), (4), and (5) show that there is a mediating effect of government supply of basic public goods in the relationship between local government competition and perception of social fairness, thus forming an internal mechanism of "local government competition → reduction of government supply of basic public goods → reduction of perception of social fairness." Local government competition leads the government to invest financial resources in infrastructure projects for the sake of economic growth while squeezing out the supply of basic government public goods such as public education, health care, and social security, thus increasing residents' perceptions of social unfairness.

Corruption effect

Finally, the mechanism of the role of corruption in local government competition in reducing residents' perception of social fairness is examined. The regression coefficient of the local

TABLE 5 Results of testing the mechanism of the intrinsic effect of local government competition on residents' perceptions of social fairness.

Variables	Income Disparity			Basic Public Services		Corruption	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	fair	tier	fair	fuwu	fair	corrpt	fair
gov	−0.048***	0.016***	−0.052***	−0.025***	−0.026*	2.617***	−0.026**
	(−4.22)	(5.23)	(−4.32)	(−5.83)	(−1.80)	(−3.45)	(−2.13)
tier			0.244**				
			(1.12)				
fuwu					−0.900**		
					(2.56)		
corrupt							−0.009***
							(5.42)
gender	0.032	0.001	0.032	−0.000	0.032	0.031	0.032
	(1.44)	(0.87)	(1.43)	(−0.10)	(1.44)	(0.23)	(1.43)
nation	−0.106**	−0.005***	−0.105**	0.024***	−0.128***	4.072***	−0.142***
	(−2.36)	(−3.69)	(−2.34)	(14.13)	(−2.81)	(15.40)	(−3.11)
edu	0.034***	0.001***	0.033***	−0.000*	0.034***	−0.153***	0.035***
	(3.91)	(3.41)	(3.86)	(−1.73)	(3.96)	(−2.78)	(4.07)
party	0.054	−0.006***	0.056	0.001	0.053	−0.043	0.055
	(1.49)	(−3.23)	(1.53)	(1.14)	(1.46)	(−0.20)	(1.51)
hukou	−0.104***	0.016***	−0.108***	−0.009***	−0.096***	−1.123***	−0.095***
	(−3.93)	(13.68)	(−4.06)	(−10.48)	(−3.62)	(−6.43)	(−3.58)
status	0.091***	−0.000	0.091***	0.000	0.091***	−0.102**	0.092***
	(10.81)	(−0.43)	(10.81)	(0.48)	(10.81)	(−2.10)	(10.92)
marry	−0.071***	−0.005***	−0.069***	0.003***	−0.073***	0.560***	−0.075***
	(−2.68)	(−3.60)	(−2.63)	(4.03)	(−2.79)	(3.48)	(−2.86)
age	0.011***	0.001***	0.011***	−0.001	0.011***	−0.018***	0.011***
	(12.80)	(4.44)	(12.72)	(−0.25)	(12.81)	(−3.27)	(12.96)
health	0.057***	−0.001**	0.057***	0.002***	0.056***	−0.113	0.058***
	(4.60)	(−2.07)	(4.63)	(4.57)	(4.49)	(−1.54)	(4.69)
income_family	−0.073***	0.004***	−0.074***	−0.005***	−0.069***	−0.828***	−0.066***
	(−5.64)	(7.74)	(−5.70)	(−13.08)	(−5.27)	(−10.33)	(−5.10)
economy_family	0.133***	−0.002**	0.133***	0.003***	0.130***	0.294***	0.130***
	(7.00)	(−2.52)	(7.03)	(5.10)	(6.86)	(2.64)	(6.87)
N	20,075	20,075	20,075	20,075	20,075	20,075	20,075
R2	0.240	0.193	0.245	0.467	0.251	0.216	0.259

***, **, * indicate statistically significant at the 1, 5, and 10% levels, respectively. t-values in parentheses.

government competition variable in column (6) of Table 5 is significantly positive at the 1% statistical level, indicating that local government competition leads to corruption. Further, both the explanatory variable local government competition, and the mediating variable corruption are placed in column (7). The regression results show that the coefficient of the local government competition variable is significantly negative and significantly reduced compared to the coefficient of the local government competition variable in column (1). In addition, the coefficient of corruption is significantly negative, implying that corruption inhibits the perception of fair social fairness. In summary, the regression results in columns (1), (6), and (7) show that there is a mediating effect of corruption between local government competition and residents' perceptions of social fairness, thus forming an internal mechanism of "local government competition → increased corruption → decreased perceptions of social fairness." That is, local government competition increases corruption and thus decreases residents' perceptions of social fairness. The effect of local government competition increases corruption and thus reduces residents' perceptions of social fairness.

Heterogeneity analysis

There may be group heterogeneity in the effect of local government competition on the perceptions of residents' social fairness. This paper further analyzes the heterogeneity of the effect

of local government competition on the perception of social fairness across different income groups, urban and rural groups, and geographic groups. The regression results are shown in Table 6.

Heterogeneity analysis of different income groups

The degree of perception of social fairness is not consistent across income class groups. To examine whether there are differences in the effects of local government competition on the Perceptions of social fairness among different income class groups, all samples are divided into three groups in this section, with the first one-third being the low-income sample, the middle being the middle-income sample, and the second one-third being the high-income sample according to the principle of three equal annual personal income, and then regressed using an ordered probit model. The results are shown in Table 6, in which the coefficients of local government competition variables in columns (1) and (2) are significantly negative, and the coefficients of local government competition variables in column (3) are not significant, which can be seen that local government competition has some differences on the social fairness Perceptions of individual residents in different income groups. In general, local government competition has a significant negative effect on the social fairness of middle-income and high-income groups, but not on the social fairness of low-income groups. The possible reason is that local government competition helps to increase the income of high-income social groups to the detriment of low-income social groups, and the effect of local government on increasing the income of high-income groups is more prominent (Jia and Liang, 2020). In addition, social benefits provided by the government, such as basic public services, are often characterized by status and privilege in China, with higher benefits for higher-income groups, and the bottom-class workers or migrant workers, who make up the majority of China's population, do not enjoy the benefits of public systems such as social security. Precisely because low-income groups have lower levels of access to income-increasing effects and public services, they are not as sensitive as high-income groups to

TABLE 6 Heterogeneity test results of the effect of local government competition on the perception of social fairness.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Low-income	Middle-income	High-income	Rural	Towns	East	Central	West
gov	−0.035	−0.062***	−0.050***	−0.033*	−0.053***	−0.049***	−0.030***	−0.120***
	(−1.50)	(−3.17)	(−2.58)	(−1.86)	(−3.40)	(−2.91)	(−1.12)	(−3.60)
gender	0.072*	0.000	−0.003	0.032	0.010	0.061*	0.051	−0.059
	(1.69)	(0.00)	(−0.09)	(1.03)	(0.32)	(1.89)	(1.20)	(−1.29)
nation	−0.107	−0.070	−0.220**	−0.152***	−0.077	−0.016	−0.280***	−0.130
	(−1.49)	(−0.88)	(−2.41)	(−2.61)	(−1.05)	(−0.26)	(−2.70)	(−1.34)
edu	0.063***	0.022	0.004	0.055***	0.003	0.021*	0.035**	0.041**
	(3.50)	(1.36)	(0.27)	(3.66)	(0.30)	(1.70)	(2.06)	(2.29)
party	0.079	−0.000	0.140***	0.033	0.112**	0.061	0.176**	−0.047
	(0.73)	(−0.01)	(2.77)	(0.48)	(2.50)	(1.25)	(2.22)	(−0.59)
hukou	−0.129**	−0.089**	−0.022	——	——	−0.161***	−0.149***	−0.016
	(−2.54)	(−2.02)	(−0.43)			(−3.90)	(−3.05)	(−0.32)
status	0.079***	0.103***	0.096***	0.076***	0.115***	0.102***	0.092***	0.078***
	(5.40)	(7.18)	(6.49)	(6.73)	(9.02)	(8.41)	(5.56)	(4.57)
marry	−0.127***	−0.057	0.025	−0.111***	−0.005	−0.039	−0.086	−0.075
	(−2.76)	(−1.15)	(0.54)	(−2.83)	(−0.14)	(−1.01)	(−1.64)	(−1.37)
age	0.016***	0.010***	0.006***	0.015***	0.006***	0.010***	0.012***	0.013***
	(10.40)	(6.48)	(3.89)	(12.17)	(5.01)	(7.62)	(7.26)	(7.07)
health	0.049**	0.059***	0.049**	0.053***	0.049**	0.029	0.086***	0.056**
	(2.37)	(2.69)	(2.14)	(3.23)	(2.56)	(1.62)	(3.42)	(2.21)
income_family	−0.069***	−0.064**	−0.027	−0.063***	−0.057**	−0.057***	−0.103***	−0.058**
	(−3.64)	(−2.04)	(−0.86)	(−3.91)	(−2.51)	(−2.87)	(−4.17)	(−2.20)
economy_family	0.162***	0.138***	0.103***	0.131***	0.133***	0.138***	0.125***	0.122***
	(4.80)	(4.11)	(3.15)	(5.05)	(4.64)	(4.98)	(3.39)	(3.14)
N	6,491	6,756	6,828	12,841	7,234	8,163	5,689	6,233
R2	0.341	0.250	0.196	0.272	0.255	0.261	0.307	0.220

***, **, * indicate statistically significant at the 1, 5, and 10% levels, respectively. t-values in parentheses.

income-increasing effects and basic public government services, and thus local governments have a more significant impact on the perceptions of social fairness of the middle-income and above groups.

Urban–rural heterogeneity analysis

The urban–rural dichotomy can have different effects on local government behavior and the social attitudes of residents in the jurisdiction. To explore whether there is a difference in the perception of social fairness of local government competition for different household registration groups, this section divides the entire sample into urban and rural groups according to household registration, on which equation (1) is estimated using an ordered probit model. The regression results are shown in columns (4) and (5) of Table 6. The regression results are shown in columns (4) and (5) of Table 6, and the coefficients of the local government competition variables are significantly negatively correlated for individuals with different household registration. However, in general, local government competition has a greater impact on the perception of social fairness for urban residents than for rural residents. This phenomenon may be due to the fact that while local government competition increases the level of urban development, economic development has an impact on the population's expectations of social mobility. It has been shown that economic development has an impact on residents' perceptions of social fairness through the inherent transmission mechanism of social mobility expectations. In the process of modern social transformation and urban upgrading, rapid economic growth has expanded regional mobility, and the rural working population has successively flocked to the cities, receiving more job opportunities and opportunities for horizontal mobility with regional transfers. In contrast, urban residents have fewer opportunities for horizontal mobility, and the social mobility expectations of rural household residents and farmers are higher than those of urban residents, thus triggering negative and complaining urban residents about their perceptions of the community (Samuel and Huntington, 2015).

Regional heterogeneity analysis

There are large disparities in the degree of local government competition across regions. To examine whether there are differences in the effects of local government competition on residents' perceptions of social fairness in different regions, this section further divides the entire sample into eastern, central, and western regions, on which equation (1) is estimated using an ordered probit model. The regression results are shown in columns (6), (7), and (8) of Table 6. The coefficients of the local government competition variables in different regions are significantly negative, indicating that local government competition significantly impairs the perceptions of social equality of residents in each region, but among them, it has the greatest impact on the perceptions of social equality in the eastern region and the least impact in the central and central-western regions. This may be because local government competition exacerbates interregional inequality in public services. In a system of political centralization and economic decentralization, the central government's transfer policy becomes a tool to manage the behavior of local governments smoothing the inter-regional ability to pay, with the greatest inequality in public services in the eastern region, followed by the central region, while public services in the western region are generally less equal and relatively balanced than those in the east (Zhao and Fu, 2017).

Discussion

Based on micro-survey data from the years 2013, 2015, and 2017 China General Social Survey (CGSS) and macro-government level data. This paper empirically analyzes the effect and mechanism of local government competition on residents' subjective perceptions of social fairness using an ordered probit model. The main findings of this paper are: (1) local government competition has a significant inhibitory effect on residents' subjective social fairness perceptions, and this finding still holds after a series of tests. (2) In terms of mechanism of action, local government competition expands residents' subjective social unfairness through widening income disparity, affecting the supply of basic government public goods, and increasing corruption. (3) Local government competition has a significant negative effect on the social fairness perceptions of the middle-income as well as the high-income groups but does not affect low-income groups. (4) For rural residents, the effect of local government competition on urban residents' subjective perceptions of social justice is greater. (5) There are differences in the effects of local government competition on residents' subjective perceptions of social justice in different regions, among which residents in eastern and central regions are more affected than those in western regions.

Conclusion

By analyzing the above findings, this paper draws the following insights:

Firstly, this study finds that local government competition in a "promotion tournament" centered on economic development reduces residents' sense of social equity. Therefore, it is necessary to change the one-dimensional competition model with economic development as the core indicator in the "promotion tournament." Improve the competition mechanism and assessment mode of local governments, and participate in the competition with different objectives, so as to build a multiple competition mode of social fairness and economic development. Improving the government's governance capacity and competition mechanism

promotes the consistency and balance between competing goals from a long-term perspective when local governments actively pay attention to the social and livelihood demands of residents in their jurisdictions.

Secondly, this study finds that local government competition reduces residents' sense of social equity through the path of crowding out the government's supply of essential public goods. Therefore, local governments should optimize the structure of public expenditure. The government's supply of basic public services has a non-negligible impact on people's perceptions of social fairness. The government should increase its financial investment in the supply of basic public goods and further improve the equalization of basic public services such as education, health care, and social security among different income groups through system reform, especially the investment in social welfare for the bottom group is especially important, which will help improve different social groups' perceptions of social access to public welfare and perceptions of social fairness.

Thirdly, this paper finds that local government competition reduces residents' sense of social justice by widening the income between residents. Therefore, the government should further narrow the gap between the rich and the poor, and build a harmonious and fair society of common prosperity. Excessive income disparity is a challenge that has to be faced in the process of achieving common wealth, and income disparity is still a major factor affecting social justice. The government should strengthen income distribution and regulation policies to optimize resource allocation and coordinate urban–rural and regional economic development, and reduce the urban–rural income gap and regional income gap so that the public can share the economic fruits of reform and opening up.

Fourthly, this study finds that local governments amplify residents' sense of social inequity through corruption. Therefore, the government should insist on continuous anti-corruption sustained adherence to anti-corruption should never be a phase, but rather a policy tool that should be sustained. Corruption curbs private investment and reduces the efficiency of public investment, and the resulting social inequality and low income of the population can cause public discontent. The government should insist on anti-corruption and strengthen anti-corruption institution building and propaganda, but also can improve residents' perception of social fairness by directing the public's attention from an anti-corruption performance such as specific corruption cases, amounts, and numbers, to the effect of anti-corruption on narrowing income disparity and promoting social fairness.

Finally, the negative effects of economic competition among local governments should not be blamed and denied, but the most important thing is to build a reasonable and orderly competition model for local governments and to motivate and mobilize local governments to participate in the competition to achieve the goal of coordinated economic and social development in the system design.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material; further inquiries can be directed to the corresponding author.

Author contributions

JY conceived and designed this study, analyzed the data, and wrote the paper. JL completed conception and the funding acquisition. All authors contributed to the article and approved the submitted version.

Funding

This work was supported by the Youth Program of the National Social Science Foundation of China (No. 17CGL013).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Adams, S. (1963). Towards an understanding of unfairness. *J. Abnorm. Psychol.* 67, 422–436. doi: 10.1037/h0040968

Alesina, L., and Eliana, F. (2002). Who trusts others? *J. Public Econ.* 85, 207–234. doi: 10.1016/S0047-2727(01)00084-6

Anderson, C. J., and Tverdova, Y. V. (2003). Corruption, political allegiances, and attitudes toward government in contemporary democracies. *Am. J. Polit. Sci.* 47, 91–109. doi: 10.1111/1540-5907.00007

Cai, M., and Yue, X. M. (2016). The main cause of income inequality in my country: market or government policy? *Finance and Econom. Res.* 4, 4–14.

Cheng, Y. H. (2007). The evolution of the national overall Gini coefficient and its urban-rural decomposition since the reform. *Chinese Social Sci.* 4, 45–60.

Chu, M., and Jin, T. (2013). Government paradox, state-owned Enterprise monopoly and income disparity: An empirical test based on the characteristics of

China's transformation. *China's Industrial Economy.* 2, 18–30. doi: 10.19581/j.cnki.ciejournal.2013.02.002

Feng, X., and Su, Z. H. (2021). The impact of economic development on the perceptions of social fairness: An analysis based on social mobility expectations. *Sociol. Sci.* 5, 86–93.

Fu, Y. (2010). Fiscal decentralization, government governance and the supply of non-economic public goods. *Econ. Res.* 8, 4–15.

Fu, Y., and Zhang, Y. (2007). Chinese-style decentralization and fiscal expenditure structure bias: the price of competition for growth. *Manage. World* 3, 4–22.

He, X., Ma, J., Zhu, L. N., and Li, X. C. (2016). The distortion of corruption on the allocation of Entrepreneurs' activities. *China Industrial Economy.* 12, 106–122. doi: 10.19581/j.cnki.ciejournal.2016.12.008

Huang, C. C., and Zhou, Y. A. (2001). The origin, development, and limitations of local government competition theory. *J. Renmin University of China.* 3, 97–103.

Jia, J. X., and Liang, X. (2020). Local government financial revenue and expenditure competition strategy and resident income distribution. *China's Industrial Economy* 11, 5–23. doi: 10.19581/j.cnki.ciejournal.2020.11.011

Jin, W. H. (2017). Institutional competition, institutional complementarity and institutional learning: the path of local government institutional innovation. *Chinese Administration* 05, 15–19. doi: 10.3782/j.issn.1006-0863.2017.05.03

Ke, W. G., and Shi, M. F. (2000). *Institutional economics: Social order and public policy*. Beijing: Commercial Press.

Kees, V. D. (2003). On the subjective quality of social justice: the role of effect as information in the psychology of justice judgments. *J. Pers. Soc. Psychol.* 3, 482–498.

Li, C. L. (2006). Comparative analysis of social injustice among all classes. *Hunan Social Sci.* 1, 71–76. doi: 10.3969/j.issn.1009-5675.2006.01.018

Li, J. T. (2016). Fiscal decentralization, information disclosure, and official corruption—based on the double examination of macro and micro institutional environment. *Account. Economic Res.* 3, 25–44. doi: 10.16314/j.cnki.31-2074/f.2016.03.002

Li, X. M., Gui, Y., and Huang, R. G. (2018). The supply of government basic public services and the perceptions of social justice—a research based on CGSS 2010. *Sociol. Sci.* 7, 89–97. doi: 10.13644/j.cnki.cn31-1112.2018.07.009

Li, L. L., Tang, L. N., and Qin, G. Q. (2012). Worry about unfairness, and even more injustice - a perceptions of fairness and perceptions of conflict in the transition period. *J. Renmin University of China.* 4, 80–90.

Li, J. L., and Xu, Y. X. (2021). The evolution and reasons of China's Residents' income distribution pattern: An investigation based on Marxist political economy. *Nankai Economic Res.* 1, 36–57. doi: 10.14116/j.nkes.2021.01.004

Li, W. B., and Zhang, R. (2021). The impact of anti-corruption on the perceptions of social justice-a quasi-natural experiment in the context of strict governance of the party. *J. South China University of Techn.* 2, 91–104. doi: 10.19366/j.cnki.1009-055X.2021.02.009

Lin, W. R. (2001). The deep immanence of social judgment. *J. Fujian Institute of Educ.* 3, 60–61. doi: 10.3969/j.issn.1673-9884.2001.03.020

Ling, W., and Liu, C. (2018). Research on the influence of income inequality on Residents' perceptions of social justice and its mechanism-empirical analysis based on CGSS2013 micro-survey data. *Statistics and Manag.* 6, 109–113. doi: 10.16722/j.issn.1674-537x.2018.06.028

Lou, G. Q. (2010). When can competition effectively restrain government? *Econ. Res.* 12, 23–34.

Ma, L., and Liu, X. (2010). Research on the perceptions of distributional justice among Chinese urban residents. *Sociol. Res.* 5, 31–49.

Mauro, P. (1995). Corruption and growth. *Q. J. Econ.* 110, 681–712. doi: 10.2307/2946696

Miao, X. L., Wang, T., and Gao, Y. G. (2017). The impact of the transfer payment on the gap between urban and rural public services - grouping comparison of different economic catching up provinces. *Econ. Res.* 2, 1–15.

Moting, H. (2009). How Chinese people view the current social inequality. *Sociol. Res.* 1, 96–120.

Oates, W. E. (1972). *Fiscal Federalism*. New York: Harcourt Brace Jovanovich.

Pan, C. Y., and Wu, B. J. (2019). Corruption control, private sector participation in infrastructure provision and anti-poverty effects: empirical evidence from developing countries (1996-2014). *Southern Economy.* 1, 60–80. doi: 10.19592/j.cnki.scje.350884

Samuel, P., and Huntington, W. G. (2015). *Political order in a changing society*. Shanghai: Shanghai People's Publishing House.

Sun, W. X., and Zhang, Z. C. (2004). The impact of fiscal expenditure structure on economic growth and social fairness. *J. Shanghai University of Finance and Economics.* 6, 3–9. doi: 10.3969/j.issn.1009-0150.2004.06.001

Tang, Z. J., Xiang, G. X., and Chen, Y. (2013). Research on promotion championships and corruption of local government officials. *Shanghai Economic Res.* 4, 3–14.

Tian, B. H., and An, B. L. (2019). Not suffering from poverty but suffering from helplessness: a study on the impact of social fairness of urban and rural residents in difficulties. *J. Huazhong Agricultural University (Social Science Edition).* 1, 97–106. doi: 10.13300/j.cnki.hnwkxb.2019.01.011

Tiebout, C. M. (1956). A pure theory of local expenditures. *J. Polit. Econ.* 64, 416–424. doi: 10.1086/257839

Van Prooijen, J. W., Keers, L. E., and Allan, W. H. (2006). How do people do react Tonegative procedures? On the moderating role of Authority's biased attitudes. *J. Exp. Soc. Psychol.* 42, 632–645. doi: 10.1016/j.jesp.2005.11.004

Wang, W. F. (2021). Investment impulse, debt expansion, and local government incentive objectives. *Finance and Trade Res.* 1, 52–68. doi: 10.19337/j.cnki.34-1093/f.2021.01.005

Weng, D. J. (2010). Psychological factors in class or class consciousness: a perceptions of fairness and attitudes. *Sociol. Res.* 1, 85–110.

Xie, Y., and Zhou, X. (2014). Income inequality in today's China. *Proc. Natl. Acad. Sci. U. S. A.* 111, 6928–6933. doi: 10.1073/pnas.1403158111

Yu, H. Y., Cui, J., Lian, X. M., and Guo, R. (2021). Insist on promoting the construction of a community with a shared future for mankind. *Northeast Asia Forum.* 6, 3–23. doi: 10.13654/j.cnki.naf.2021.06.001

Zhang, L. (2017). How does government competition affect regional economic growth? *Economic Economics* 4, 13–18. doi: 10.15931/j.cnki.1006-1096.2017.04.003

Zhang, H. L., and Chen, X. (2006). The impact of financial competition on the structure of local public expenditures—taking China's investment competition as an example. *Comp. Econ. Soc. Syst.* 6, 57–64. doi: 10.3969/j.issn.1003-3947.2006.06.011

Zhang, T., and Fu, Y. L. (2009). Public goods supply, perceptions of fairness and income distribution. *Academic Monthly.* 5, 81–87.

Zhang, J., Gao, Y., and Fu, Y. (2007). Why does China have a good infrastructure? *Econ. Res.* 3, 4–19.

Zhang, Y., and Zhao, Y. P. (2017). Fiscal decentralization, promotion incentives and infrastructure investment-a spatial econometric analysis based on provincial panel data in China. Exploration of. *Economic Issues* 12, 1–9.

Zhao, Y. H., and Fu, W. L. (2017). Transfer payment, financial equalization and regional public goods supply. *Fiscal Res.* 5, 13–23. doi: 10.19477/j.cnki.11-1077/f.2017.05.002

Zheng, S. Q., Fu, Y. M., and Liu, H. Y. (2005). An empirical study on urban Residents' preference for residential location and location selection. *Econ. Geogr.* 2, 194–198. doi: 10.3969/j.issn.1000-8462.2005.02.013

Zhou, Y. A. (2003). Local government competition and economic growth. *J. Renmin University of China.* 1, 97–103.

Zhou, L. A. (2004). Incentives and cooperation of government officials in the promotion game-also on the reasons for the long-term existence of local protectionism and duplicate construction in my country. *Econ. Res.* 6, 33–40.

Zhou, L. A., and Tao, J. (2009). Research on government scale, marketization and regional corruption. *Econ. Res.* 1, 57–69. doi: 10.1007/s11459-009-0023-2

Zodrw, G. R., and Mieszkowski, P. T. (1986). Property taxation, and the Underprovision of local public goods. *J. Urban Econ.* 19, 356–370. doi: 10.1016/0094-1190(86)90048-3

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 06 January 2023
DOI 10.3389/fpsyg.2022.1082399

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OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Personality and Social Psychology, a section of the journal Frontiers in Psychology

RECEIVED 28 October 2022
ACCEPTED 13 December 2022
PUBLISHED 06 January 2023

CITATION
Huang T, Lyu H, Chen X and Ren J (2023) The relationship between sense of community and general well-being of Chinese older adults: A moderated mediation model.
Front. Psychol. 13:1082399.
doi: 10.3389/fpsyg.2022.1082399

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The relationship between sense of community and general well-being of Chinese older adults: A moderated mediation model

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As China becomes an aging society, the impacts of the aging population on the social meso domain, namely, the community level, have received increasing attention in recent years. However, relevant studies are limited. With the assumption that regular community participation positively influences well-being, this study investigated the mediating role of community participation between the sense of community and the general well-being of Chinese older adults and the moderating role of social support. A questionnaire survey was conducted with a valid sample size of 566 participants aged 60 and above in the urban communities of Chongqing, Chengdu, and Zunyi in southwest China. Moderated mediation models were constructed to explore factors related to the well-being of older adults, finding that encouraging community participation can improve the general well-being of older adults and build a better society in Chinese cities. The main findings of this study are as follows: (1) a sense of community significantly and positively relates to community participation and general well-being; (2) community participation partially mediates the relationship between sense of community and general well-being; and (3) each pathway through which sense of community influences older adults' general well-being is moderated by social support.

KEYWORDS

sense of community, community participation, social support, general well-being, older adults, China

1. Introduction

Currently, China is in a period of social transformation, and the problem of its aging population is becoming increasingly serious. According to the seventh national census in 2020, the number of people aged 60 and above was about 260 million, accounting for 18.7% of the Chinese population (National Bureau of Statistics of China, 2021). It is predicted that by 2050, the population aged 60 and above will reach 492 million (34.8%). More and more policymakers and professional researchers are concerned about how to deal with the aging

problem and how to ensure active aging and happy in later life. According to Maslow's Hierarchy of Needs, when lower-level needs such as security and physiological needs are met, people begin to seek higher-level needs such as belonging, respect, and self-actualization, and older adults are no exception (Cooper et al., 2017). For example, a sense of community is a resource enabling people to meet their physical and psychological needs. When the community meets the needs of individuals, community members are more willing to participate in community activities, improve the community environment, and remain stable residents in the community over time (McMillan and Chavis, 1986; Nowell and Boyd, 2010).

Sense of community (SOC), a core concept in community psychology, is defined as "the sense that a person is part of a ready-made, mutually supportive network of relationships" (Sarason, 1974). SOC can be conceptualized in two dimensions: geographical and relational factors and individual-level and community-level factors, both of which can influence the SOC (Sagy et al., 1996). Research on SOC involves the health of a community, as well as the level of community or social participation, social well-being, academic success, empowerment, social cohesion, belongingness, and individual needs being met within a community setting (Chipuer and Pretty, 1999; Cicognani et al., 2008; Jacobs and Archie, 2008; Talò et al., 2014). Scholars agree that a higher level of SOC can positively impact communities and individuals (Talò et al., 2014). However, only a few studies quantify the effects of community participation on SOC and well-being. To address this research gap, this paper tends to estimate the mediating effect of community participation (CP), between SOC and general well-being (GWB), and social support (SS), which moderate the mediating effect above.

Previous studies found that older adults have a higher level of SOC than young and middle-aged adults, and that SOC increases with age, especially with old age (Jorgensen et al., 2010). Older adults, especially those with limited mobility, spend most of their time in local communities. According to the social resource theory (Lin, 2001), SOC can be considered as an intangible resource that can meet people's physical and psychological needs, thereby increasing the likelihood of increased participation in community activities (Mak et al., 2009). SOC based on the theoretical model of needs has been empirically supported at two individual levels: mental health and community participation. For example, a psychological SOC has been found to be a predictor of volunteerism in older adults (Omoto and Packard, 2016). Researchers (Liu et al., 2017) also found that SOC is enhanced by participation in community activities. Therefore, SOC, as an aspect of social relationships, is important for an individual's GWB.

Social support refered to the material and moral support that individuals receive from social relationships such as those with relatives, friends, colleagues, or group organizations (Liu and Huang, 2010). The authors suggested that good social support can play a positive role when individuals experience emergencies and unexpected situations, helping individuals to move beyond a brief period of low mood. Xiao (1994) classified social support as subjective support, objective support, and support utilization. According to Lin and Yeh (2014), social support affects individuals' cognitive evaluations, thereby improving their adaptability to the environment. Social support makes individuals believe they are cared for and cared about, thereby reducing their psychological needs (Chen and Zhang, 2021). The physical and mental health of older adults is related to social support. When social support and relationship networks shift, the physical and mental health of older adults might be affected. Especially under the influence of the Chinese mainstream social thinking that "old and frail, unable to take care of themselves and in need of social assistance," elders gradually develop psychological dependence and behavioral inaction, and social support becomes the emotional guarantee and spiritual support to maintain the community participation of the elderly (Chen, 2014).

Emotional social support such as encouragement, support, understanding, and respect can provide emotional comfort and spiritual support for a greater sense of well-being in older adults. According to the social–emotional choice theory, individuals place more emphasis on companionship and emotional social support systems in later life, thereby diverting individuals' attention and energy to their own physical and mental health needs (Chu et al., 2010). Meta-analysis has found that social support and subjective well-being are moderately correlated, confirming the positive effects of social support (Yao et al., 2018). Tovel and Carmel (2014) found that integrated social support can indirectly affect the subjective well-being of older adults *via* coping resources (i.e., a strong sense of community) and coping patterns (i.e., community participation). This finding is consistent with the findings of Liddle et al. (2014), which found that older adults, especially as they become increasingly frail, are able to receive support and feel happy in the environment they are accustomed to.

Community participation, as one of the main components of active aging, advocates that older adults should engage in society in a holistic manner, a view that is becoming a common consensus in addressing population aging globally. For example, Fowler and Christakis (2008) found that increased community participation behaviors and higher identity with community life affect residents' evaluation of their Sense of community, thereby enhancing their well-being. The importance of community participation on older adults' well-being was also documented by Au et al. (2020) in China. Jiang (2009) found that older adults are a major component of community participation, and involvement in community activities (i.e., volunteer activities and senior citizens clubs) can meet older adults' social needs. By actively participating in community activities, older adults can increase opportunities to communicate with others, gain recognition, enhance psychological resilience, reduce feelings of helplessness, and gain a sense of self-worth and well-being.

Identifying feasible ways to encourage older adults to participate in community affairs and enhance their sense of well-being can help to identify the current situation of social support and community participation of older adults and enrich knowledge about their SOC and well-being. For example, Baker

and Palmer (2006) found that longer participation and more activities are predictive of better well-being. A study in Taiwan found that participation in community activities enhances older adults' sense of closeness and connectedness to other community members, helping them avoid feelings of rejection and isolation (Chen et al., 2015). Another study in Hong Kong found that participation in volunteer activities can improve the quality of life of older adults (Au, 2015). In mainland China, scholars found that older adults experienced a sense of accomplishment after being involved in various recreational activities, and participating in voluntary services (i.e., community policing patrols), enabling them to experience the realization of self-worth, meaningfulness, and fullness of life. These enhancements should therefore involve sustaining opportunities for developing and maintaining significant relationships, participating in the community in ways meaningful to them, and access to community and health services (Chaudhury et al., 2012; Wahl et al., 2012; Scharlach and Lehning, 2013).

Based on the above literature review, this study proposes a hypothetical model of the relationships among sense of community, social support, community participation, and general well-being of older adults (see Figure 1). This study conducted questionnaire surveys with older adults in southwest Chinese urban communities to test the model.

2. Methodology

2.1. Data collection

In 2022, 588 anonymous questionnaires were collected by online survey using convenience sampling. Posters in community centers were used to source respondents. The samples were collected from the urban communities of Chongqing, Chengdu, and Zunyi. All three cities are located in southwest China, an area considered a less developed region of the country. Participation was completely voluntary, and respondents could skip any questions they preferred not to answer. The survey consisted of five parts: the first section concerned participants' sense of community; the second section measured older adults' community participation; and the third and four sections collected respondents' views on social support and general well-being, respectively. The last section collected the social and demographic information of the respondents, including age, gender, and monthly income. Questionnaires were sorted and checked to remove incomplete entries. After data cleaning, 566 valid survey entries remained, a return rate of 96.26%.

The gender and marital status composition of participants were identical to the census (National Bureau of Statistics of China, 2021). Out of 566 participants, 248 (43.82%) were male, and 318 (56.18%) were female. In terms of marital status, 450 were married, 11 were living together, 42 were unmarried, and 63 were divorced or widowed. In terms of socio-economic characteristics, however, participants in this study tended to be more educated and have a higher income than the national average. In terms of education attainment, 136 respondents had bachelor's degrees and above, 312 were high school graduates, and 118 had completed junior high school and below. Monthly income was classified into four categories as follows: 40 participants earned less than 2,000RMB, 286 earned between 2,000 and 5,000RMB, 164 earned between 5,000 and 8,000RMB, and 76 earned between 8,000RMB, and above.

2.2. Data processing

After data cleaning, a series of descriptive analyzes, including analysis of variance, and Pearson's correlation analysis, were performed using SPSS 25.0. Next, we used Hayes (2018) PROCESS macro (Model 4) to examine the mediating effect of the community participation on the relationship between the sense of community and the general well-being. In addition, we examined whether the social support moderated the mediation process with Hayes (2018) PROCESS macro (Model 59). Finally, the simple slope test was applied to explain the moderation effect. All variables were standardized before mediating and moderating effects were examined.

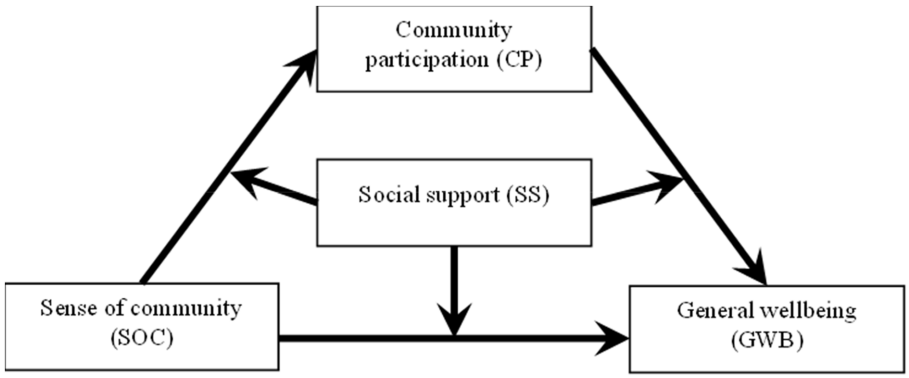

FIGURE 1
Conceptual framework.

2.3. Measurements

2.3.1. Sense of community index scale

The Sense of Community Index Scale, the second version of the Sense of Community Index scale (SCI) revised by McMillan (1996), is a quantitative measure of community sense, divided into four dimensions of membership, integration, satisfaction of needs, influence, and shared emotional connection, with a total of 24 items. Each item was scored on a 4-point scale, ranging from 1 (strongly disagree) to 4 (strongly agree). This questionnaire has been used in multiple Chinese studies (Ma et al., 2022), showing good reliability and validity. The internal consistency coefficient of the sense of community index scale in this study was 0.978.

2.3.2. The community participation questionnaire

The six-item Community Participation Questionnaire for Urban Residents (Lin and Yeh, 2014) measured residents' community participation in public affairs and private affairs. Each question of this scale was marked either "yes" (1 point) or "no" (2 point). For example, "In the past 3 months, have you participated in community public affairs maintenance activities?". This scale had been applied in various empirical studies in China (Lin and Yeh, 2014; Greenfield et al., 2016). The internal consistency coefficient of community participation in this study is 0.98.

2.3.3. Social support rating scale

This 10-item scale was designed by Xiao (1994) to measure social support in China. It includes three dimensions of social support, namely objective support, subjective support, and utilization of social support. From item-1 to item 5, each item was scored from 1 (no support) to 4 (full support) points respectively, while item 6 and item 7 were scored 0 points if respondent answered "no source" and several points if answered "the following sources". This scale had been applied in various empirical studies in China (Ren et al., 2022). The internal consistency coefficient of the social support scale in this study was 0.761.

2.3.4. General well-being schedule

This scale was proposed by Fazio (1977), and modified by Duan (1996) to evaluate subjects' statements of well-being in China (Wu et al., 2010). This scale included six factors, namely worry about health, energy, satisfaction and interest in life, depression or pleasant mood, control of emotions and behavior, and relaxation and tension (anxiety) factors, with a total of 25 items. Item 24 was deleted because 352 respondents did not answer this question. Besides, after removing item 24, the overall reliability coefficient of the scale (0.937) was higher than the original (0.91). The internal consistency coefficient of the scale was 0.91 for men and 0.95 for women, with a retest reliability of 0.85 in this study.

3. Model results

3.1. Descriptive analysis and common method bias test

To avoid common method bias, reverse scoring of items was applied during the implementation of the study, while Harma's (Fang and Sun, 2014) one-way method was adopted to operate the common method bias test. After EFA of the data of all variables, it was found that the total number of factors with eigenvalues greater than 1 without rotation was 9, and the first-factor variance explained 37.83%, lower than the critical criterion of 40%. Therefore, the data of this study did not have serious common method bias. Descriptive statistics of model variables were listed as follows (Table 1).

3.2. Test of mediating effect

As shown in Figure 2, community participation partially mediates the relationship between a sense of community and general well-being. Each pathway through which sense of community influences older adults' general well-being is moderated by social support.

The analysis of model results confirmed that CP mediates the relationship between SOC and GWB of older adults (see Tables 2, 3). The bootstrap 95% confidence interval of the mediating effect of community participation does not contain a 0 value. The direct effect was 0.146, [Bootstrap 95%, CI: (0.004, 0.288)], accounting for 32.52% of the total effect. The indirect effect was 0.303, accounting for 67.48% of the total effect [Bootstrap 95%, CI: (0.193, 0.422)], respectively. This indicates that community participation has a partial mediating effect between SOC and GWB.

3.3. Test for moderated mediating effects

First group of models measured the effects of SOC on older adults' CP without the moderating effects of SS (Table 4). Dependent variable was CP, and independent variables were SOC and SS. According to the results in model 1-a, SOC was significantly related to CP ($t = 23.944$, $p = 0.000$), indicating that SOC has a significant influence on the CP of the elderly. As shown

TABLE 1 Descriptive statistics of means, SD, and Pearson's correlations (n=566).

	SS	GWB	CP	SOC
Social support (SS)	1			
General well-being (GWB)	0.348**	1		
Community participation (CP)	0.626**	0.400**	1	
Sense of community (SOC)	0.341**	0.339**	0.710**	1
MEAN	27.700	4.178	1.186	3.110
SD	6.627	1.001	0.800	0.756

**$p < 0.01$.

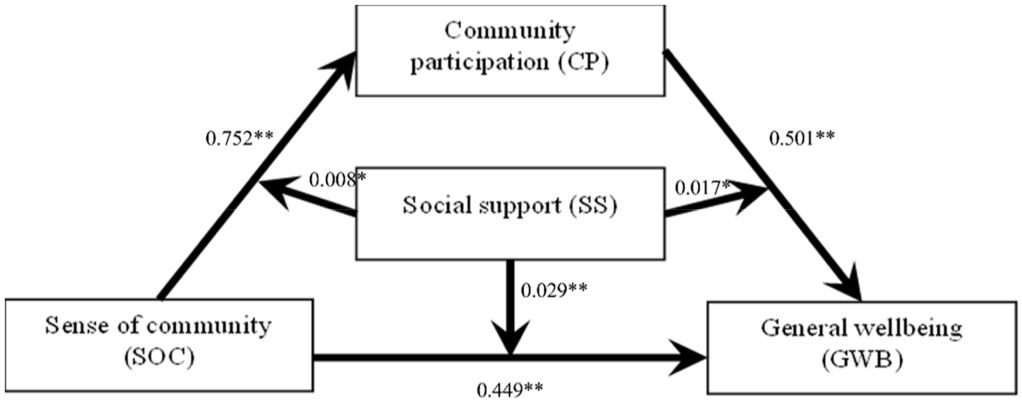

FIGURE 2
The moderated mediation model of social support and community participation. *p<0.05 and **p<0.01.

TABLE 2 Model results (N=566).

	GWB				CP				GWB			
	B	s.e.	t	β	B	s.e.	t	β	B	s.e.	t	β
Constant	2.781**	0.168	16.550	-	−1.152**	0.100	−11.467	-	3.246**	0.181	17.905	-
SOC	0.449**	0.053	8.551	0.339	0.752**	0.031	23.944	0.710	0.146*	0.072	2.016	0.110
CP									0.403**	0.068	5.892	0.322
R^2	0.115				0.504				0.166			
Adjusted R^2	0.113				0.503				0.163			

*p<0.05 and **p<0.01.

in model 1-c, the interaction term between SOC and SS was statistically significant (t = 2.032, p = 0.043), suggesting that the magnitude of the effect of the moderating variable (SS) on CP of the elderly is significantly different at different levels, as shown in the "Simple slope plot analysis (Figure 3)."

Second group of models (Table 5) measured the effects of SOC on GWB without considering the moderated effects of SS. As model 2-a shows, SOC was statistically significant (t = 8.551, p = 0.000), indicating that SOC has a significant influence on older adults' GWB. According to model 2-c, the interaction term between SOC and SS was significant (t = 3.812, p = 0.000), meaning that the magnitude of the effect of the moderating variable (SS) on GWB is significantly different at different levels, as shown in the "Simple slope plot analysis (Figure 4)."

The last set of models (models 3-a, 3-b, and 3-c) measured the mediated effects of SS between CP and GWB. As Table 6 shows, the independent variable (CP) was significant (t = 10.371, p = 0.000), indicating that CP refers to a significant influence relationship on GWB. The interaction term between CP and SS was statistically significant (t = 1.989, p = 0.047). This means that the magnitude of the effect of the moderating variable (SS) on the GWB of the elderly is significantly different at different levels, as shown in the "Simple slope plot analysis (Figure 5)."

According to Figures 3, 4, SoC had a significant positive effect on CP (i.e., one SD below the mean; β_{simple} = 0.564, p < 0.05) and GWB (i.e., one SD below the mean; β_{simple} = 0.217, p < 0.05). When the level of social support was high (i.e., one SD above the mean), the effect of SoC on CP (β_{simple} = 0.663, p < 0.05) and GWB increased (β_{simple} = 0.582, p < 0.05). That is, when older adults feel higher levels of social support, the SoC better predicts their GWB.

TABLE 3 Results of mediating effect analysis (N=566).

	Effect	BootSE	BootLLCI	BootULCI
Total effect	0.449	0.053	0.346	0.552
Direct effect	0.146	0.072	0.004	0.288
Indirect effect of CP	0.303	0.060	0.193	0.422

As shown in Figure 5, CP had a significant positive effect on GWB whatever when social support was low (i.e., one SD below the mean; β_{simple} = 0.303, p < 0.05), or the level of social support was high (i.e., one SD above the mean), the positive predictive effect of CP on GWB increased (β_{simple} = 0.511, p < 0.05).

4. Discussion

4.1. Mediating role of community participation

According to the model results, older adults' sense of community was significantly and positively related to community

TABLE 4 Sense of community and community participation: moderating roles of social support.

	Model 1-a				Model1-b				Model 1-c			
	B	s.e.	*t*	*β*	*B*	s.e.	*t*	*β*	*B*	s.e.	*t*	*β*
Constant	1.186**	0.024	50.040	-	1.186**	0.019	61.410	-	1.173**	0.020	57.945	-
SOC	0.752**	0.031	23.944	0.710	0.595**	0.027	21.858	0.562	0.613**	0.029	21.404	0.579
SS					0.056**	0.003	16.924	0.435	0.055**	0.003	16.739	0.431
SOC*SS									0.008*	0.004	2.032	0.052
R^2	0.504				0.671				0.674			
Adjusted R^2	0.503				0.670				0.672			
F	$F(1,564) = 573.312$**				$F(2,563) = 574.949$**				$F(3,562) = 386.807$**			
$\triangle R^2$	0.504				0.167				0.002			
$\triangle F$	$F(1,564) = 573.312$**				$F(1,563) = 286.437$**				$F(1,562) = 4.130$*			

*$p < 0.05$, **$p < 0.01$.

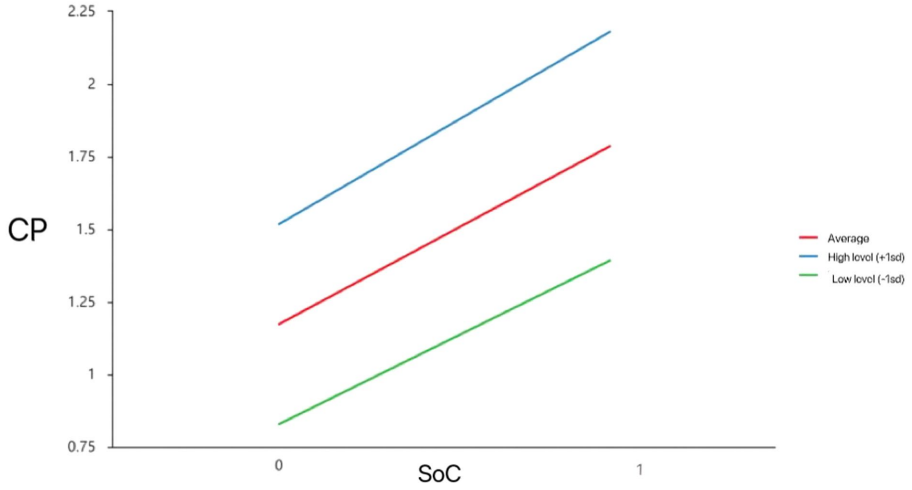

FIGURE 3
Model of test for simple slopes showing moderating influence of SS on association between SoC and CP.

participation and general well-being (Table 1). This finding suggests that older adults' sense of community in urban China can strengthen their sense of responsibility and obligation for community affairs, as well as their perception of the common good of the community, which, in turn, affects their enthusiasm for community participation. In addition, community participation is also a process of continued socialization; that is, individuals' transition from middle age to old age is a necessary stage and can be considered as the completion stage of individual socialization. This is consistent with Talò et al. (2014), who found that older adults face a transition in social and family roles after retirement, and those with a stronger sense of community can actively integrate into the social participation process, resulting in better psychological health and fewer negative emotions such as depression and anxiety (Millner et al., 2019).

This study also found that community participation had positive effects on the well-being of Chinese urban older adults, a finding in line with existing studies. For example, Hannah and Spencer (2012) confirmed that community participation, as an important component of an individual's social functioning, can provide role support to maintain self-concept and bring happiness. Positive activity theory also emphasizes that older adults should actively participate in their community and continue past activities to gain positive emotions, enjoy life, and experience happiness (Bess et al., 2002). It argues that even after retirement, maintaining activity patterns is an important foundation enabling older adults to achieve a full and happy life and improve the quality and quality of life. It is a key path to active aging. In general, older adults have become an active and important force in the practice of community participation. Older adults can not only draw spiritual nourishment and cultivate their temperament through community participation, but also adjust and adapt to their changing roles physically and psychologically, improve their life satisfaction, increase their positive emotional experience, and reduce their negative emotional experience, thereby helping them to achieve a state of happiness in their later life (Lemon et al., 1972; Lampinen et al., 2006).

10.3389/fpsyg.2022.1082399

TABLE 5 Sense of community and general well-being: moderating roles of social support.

	Model 2-a				Model 2-b				Model 2-c			
	B	s.e.	*t*	*β*	*B*	s.e.	*t*	*β*	*B*	s.e.	*t*	*β*
Constant	4.178**	0.040	105.409	-	4.178**	0.038	109.141	-	4.131**	0.040	103.872	-
SOC	0.449**	0.053	8.551	0.339	0.330**	0.054	6.125	0.249	0.400**	0.056	7.096	0.301
SS					0.042**	0.007	6.453	0.263	0.040**	0.006	6.184	0.250
SOC*SS									0.029**	0.008	3.812	0.152
R^2	0.115				0.176				0.197			
Adjusted R^2	0.113				0.173				0.192			
F	$F(1,564) = 73.121$**				$F(2,563) = 60.016$**				$F(3,562) = 45.817$**			
$\triangle R^2$	0.115				0.061				0.021			
$\triangle F$	$F(1,564) = 73.121$**				$F(1,563) = 41.642$**				$F(1,562) = 14.533$**			

*$p < 0.05$, **$p < 0.01$.

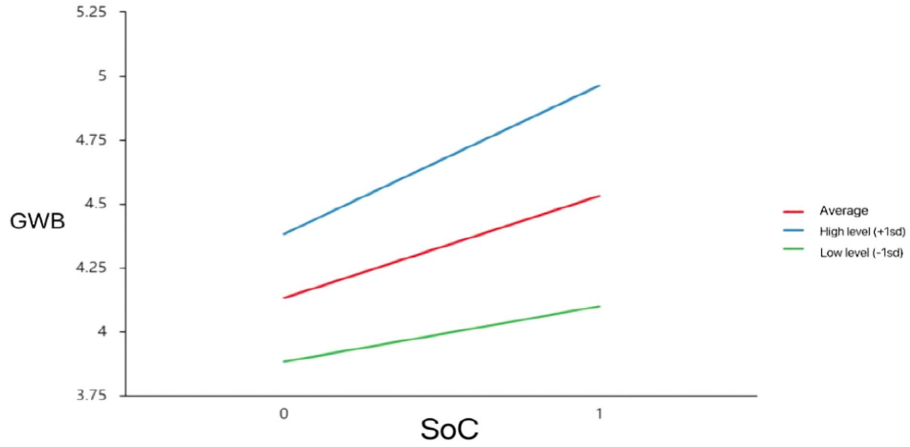

FIGURE 4
Model of test for simple slopes showing moderating influence of SS on association between SoC and GWB.

4.2. Moderating role of social support

The findings suggest that social support affects older adults' general well-being through community participation as moderating variable, and that the three pathways of SoC-GWB, SoC-CP, and CP-GWB are enhanced at different moderating levels when older adults receive higher social support. As shown in Figure 5, regardless of the level of social support, community participation had a significant positive effect on GWB, and the effect of community participation on GWB increased if the level of social support increased. This is consistent with the existing empirical findings (Chen, 2014) that when older adults have adequate levels of social support, they are more willing to participate in community activities. For example, Chen (2014) argues that most older adults attribute their increased participation in social activities to social support rather than self-factors. At the same time, the social nature of human beings determines that their behavior will be influenced by the interpersonal relationships around them, and their opinions, attitudes, and behaviors will undoubtedly affect the level of social participation of older adults. As Long and Perkins (2007) say, People's community participation behaviors are both a result of the growing abundance of community resources and they are able to meet people's needs. Therefore, our future research will explore what kinds of community activities can enhance older adults' social support, or how to facilitate their community participation behaviors through pathways that increase social support.

Nelson et al. (2016) found that active social roles, such as participation in community service and volunteer activities, are ways to achieve self-worth and enhance satisfaction and well-being. With adequate social support, older adults can have a better sense of community and are more likely to be motivated to participate in community affairs, and promoting a higher level of general well-being. This also confirmed in our findings that when older adults feel higher levels of social support, the sense of community better predicts their community participation and

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TABLE 6 Community participation and general well-being: moderating roles of social support.

	Model 3-a				Model 3-b				Model 3-c			
	B	s.e.	*t*	*β*	*B*	s.e.	*t*	*β*	*B*	s.e.	*t*	*β*
Constant	4.178**	0.039	108.220	-	4.178**	0.038	109.133	-	4.126**	0.046	89.226	-
CP	0.501**	0.048	10.371	0.400	0.376**	0.061	6.117	0.3	0.407**	0.063	6.435	0.325
SS					0.025**	0.008	3.249	0.159	0.025**	0.008	3.222	0.158
CP*SS									0.017*	0.008	1.989	0.080
R^2	0.160				0.176				0.181			
Adjusted R^2	0.159				0.173				0.177			
F	$F(1,564) = 107.553$**				$F(2,563) = 59.964$**				$F(3,562) = 41.505$**			
$\triangle R^2$	0.160				0.015				0.006			
$\triangle F$	$F(1,564) = 107.553$**				$F(1,563) = 10.553$**				$F(1,562) = 3.957$*			

*$p < 0.05$, **$p < 0.01$.

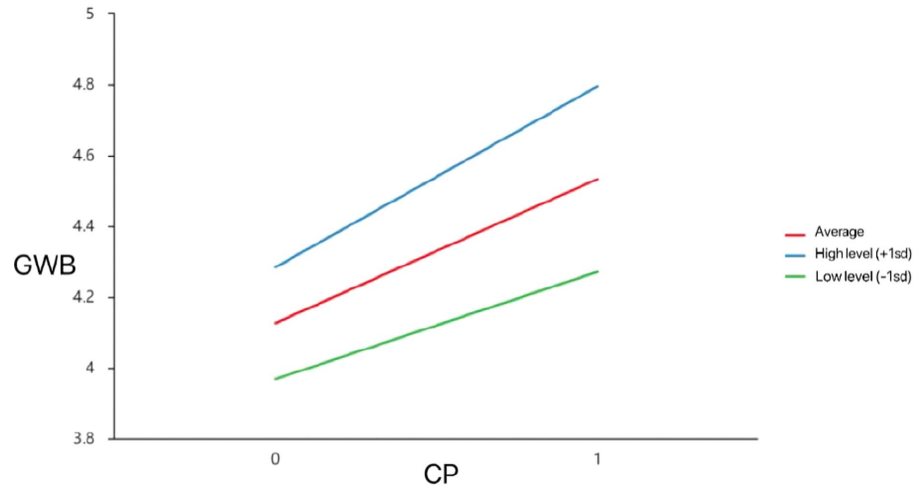

FIGURE 5
Model of test for simple slopes showing moderating influence of SS on association between CP and GWB.

general well-being (Figures 3, 4). At the same time, community participation forms a positive interpersonal interaction and social support, factors which can relieve the psychological stress of older adults and enhance their confidence and ability to cope with life events. Therefore, older adults can experience higher levels of well-being by enhancing the social support they receive.

4.3. Limitations and future studies

There are some limitations that this study plans to address in future studies. First, due to funding and capacity constraints, a convenience sampling approach was adopted for data collection, resulting in inadequate data representation. Second, the educational attainment and income level of participants are higher than the national average, indicating that the empirical validity and ecological validity of the study results are limited. Finally, self-election bias might be a problem because the online survey was distributed through community centers, and only those who are willing to participate in community activities could access the questionnaire and were more likely to answer it.

In future studies, the sample should be expanded as much as possible, for example, by including a sample of rural older adults and a sample from more regions, to obtain more representative overall research data and obtain more generalizable research results. Second, a sophisticated research method should be adopted, either through before-and-after control or by conducting a longitudinal tracking study of research results and countermeasures to improve the validation of the analysis generalizability, whereby the applicability of the analysis and countermeasures can be improved. Finally, the study could continue to explore the factors affecting the happiness of the elderly from different dimensions and aspects.

5. Conclusion

According to our questionnaire survey, older adults in urban China are experiencing relatively high levels of general well-being. Our descriptive analysis reveals that female participants have a significantly higher level of community participation and sense of community than male participants. Moreover, older adults who are better educated and those with higher income levels tend to have better general well-being. A higher sense of community is an important factor in promoting community participation and enhancing the general well-being of older adults. Cultivating a sense of community among older adults is consistent with their motivation to "play their part and make a difference in their old age," and is conducive to giving full play to their values in community participation. The social support of older adults contributes positively to their community participation and general well-being, and higher social support can promote and enhance their community participation, an important component of older adults' physical and mental health and well-being with a significant potential impact on active aging.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Funding

This work was supported by the Ministry of Education of Humanities and Social Science Project in China (No. 20YJA630011), the Digital Industrial College of Natural Resources–Development Fund Scheme (Guangxi, China), 2021 Chongqing Social Science Planning Key Project in China (No. 2021NDZD09), and the key project of Chongqing Education Science "14th Five-Year Plan" in 2021 of China (No. 2021-GX-003).

Acknowledgments

We sincerely thank our collaborators and research participants for their coordination and participation in our study. We also thank our research team for their contributions.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2022.1082399/full#supplementary-material

References

Au, A. (2015). Developing volunteer-assisted behavioral activation teleprograms to meet the needs of Chinese dementia caregivers. *Clin. Gerontol.* 38, 190–202. doi: 10.1080/07317115.2015.1008118

Au, A., Lai, D. W. L., Yip, H., Chan, S., Lai, S., Chaudhury, H., et al. (2020). Sense of community mediating between age-friendly characteristics and life satisfaction of community-dwelling older adults. *J. Front. Psychol.* 11:86. doi: 10.3389/fpsyg.2020.00086

Baker, D. A., and Palmer, R. J. (2006). Examining the effects of perceptions of community and recreation participation on quality of life. *Soc. Indic. Res.* 75, 395–418. doi: 10.1007/s11205-004-5298-1

Bess, K. D., Fisher, A. T., Sonn, C. C., and Bishop, B. J. (2002). "Psychological sense of community: theory, research, and application," in *Psychological Sense of Community*. eds. A. T. Fisher and C. C. Sonn (New York: Kluwer Academic/Plenum), 3–22.

Chaudhury, H., Mahmood, A., Michael, Y. L., Campo, M., and Kara, H. (2012). The inflfluence of neighborhood residential density, physical and social environments on older adults' physical activity: an exploratory study in two metropolitan areas. *J. Aging Stud.* 26, 35–43. doi: 10.1016/j.jaging.2011.07.001

Chen, C. F. (2014). An investigation of social support and expectations of older adults. *Psychol. Sci.* 29, 201–204.

Chen, W., Okumiya, K., Wada, T., Sakamoto, R., Imai, H., Ishimoto, Y., et al. (2015). Social cohesion and health in old age: a study in southern Taiwan. *Int. Psychol.* 27, 1903–1911. doi: 10.1017/S1041610214002907

Chen, L. S., and Zhang, Z. (2021). Community participation and subjective wellbeing: mediating roles of basic psychological needs among Chinese retirees. *J. Front. Psychol.* 12:743897. doi: 10.3389/fpsyg.2021.743897

Chipuer, H. M., and Pretty, G. M. H. (1999). A review of the sense of community index: current uses, factor structure, reliability, and further development. *J. Community Psychol.* 27, 643–658. doi: 10.1002/(SICI)1520-6629(199911)27:6<643::AID-JCOP2>3.0.CO;2-B

Chu, P. S., Saucier, D. A., and Hafner, E. (2010). Meta-analysis of the relationships between social support and well-being in children and adolescents. *J. Soc. Clin. Psychol.* 29, 624–645. doi: 10.1521/jscp.2010.29.6.624

Cicognani, E., Pirini, C., Keyes, C., Joshanloo, M., Rostami, R., and Nostratabadi, M. (2008). Social participation, sense of community and social well-being: a study on American, Italian, and Iranian university students. *Soc. Indic. Res.* 89, 97–112. doi: 10.1007/s11205-007-9222-3

Cooper, J. A., Blanco, N. J., and Maddox, W. T. (2017). Framing matters: effects of framing on older adults' exploratory decision-making. *Psychol. Aging* 32, 60–68. doi: 10.1037/pag0000146

Duan, J. H. (1996). The test results and analysis of the general well-being scale among Chinese college students. *Chin. J. Clin. Psychol.* 4, 56–57.

Fang, J., and Sun, P. Z. (2014). Analysis of multiple mediating effects based on structural equation modeling. *Psychol. Sci.* 37, 735–741.

Fazio, A. F. (1977). *A Concurrent Validation Study of the NCHI General Well-being Schedule*. Hyattsville, MD: National Center for Health Statistics.

Fowler, J. H., and Christakis, N. J. (2008). Dynamic spread of happiness in a large social network: longitudinal analysis over 20 years in the Framingham heart study. *BMJ* 337:a2338. doi: 10.1136/bmj.a2338

Greenfield, E. A., Scharlach, A. E., and Davitt, J. K. (2016). Organizational characteristics and volunteering in age-friendly supportive service initiatives. *Nonprofit. Volunt. Sec. Q.* 45, 931–948. doi: 10.1177/0899764015621620

Hannah, L. J., and Spencer, M. (2012). Network social capital, social participation, and physical inactivity in an urban adult population. *Soc. Sci. Med.* 74, 1362–1367. doi: 10.1016/j.socscimed.2012.01.005

Hayes, A. F. (2018). *Introduction to Mediation, Moderation, and Conditional Process Analysis. A Regression-based Approach. 2nd Edn*. New York: The Guilford Press.

Jacobs, J., and Archie, T. (2008). Investigating sense of community in first-year college students. *J. Exp. Educ.* 30, 282–285. doi: 10.1177/105382590703000312

Jiang, Z. H. (2009). An analysis of the current situation and causes of community participation of urban elderly. *J. Demo* 5, 38–43.

Jorgensen, B. S., Jamieson, R. D., and Martin, J. F. (2010). Income, sense of community and subjective well-being: combining economic and psychological variables. *J. Econ. Psychol.* 31, 612–623. doi: 10.1016/j.joep.2010.04.002

Lampinen, P., Heikkinen, R. L., Kauppinen, M., and Heikkinen, E. (2006). Activity as a predictor of mental well-being among older adults. *Aging Ment. Health* 10, 454–466. doi: 10.1080/13607860600640962

Lemon, B. W., Bengtson, V. L., and Peterson, J. A. (1972). An exploration of the activity theory of aging: activity types and life satisfaction among inmovers to a retirement community. *J. Gerontol.* 27, 511–523. doi: 10.1093/geronj/27.4.511

Liddle, J., Scharf, T., Bartlam, B., Bernard, M., and Sim, J. (2014). Exploring the age-friendliness of purpose-built retirement communities: evidence from England. *Ageing Soc.* 34, 1601–1629. doi: 10.1017/S0144686X13000366

Lin, N. (2001). *Social Capital: A Theory of Social Structure and Action*. Cambridge: Cambridge University Press.

Lin, C. C., and Yeh, Y. C. (2014). How gratitude influences wellbeing: a structural equation modeling approach. *Soc. Indic. Res.* 118, 205–217. doi: 10.1007/s11205-013-0424-6

Liu, Y., Dijst, M., and Geertman, S. (2017). The subjective well-being of older adults in Shanghai: the role of residential environment and individual resources. *Urban Stud.* 54, 1692–1714. doi: 10.1177/0042098016630512

Liu, X., and Huang, X. T. (2010). Social support and its mechanism for mental health. *Psychol. Res.* 3, 3–8.

Long, D. A., and Perkins, D. D. (2007). Community social and place predictors of sense of community: a multilevel and longitudinal analysis. *J. Community Psychol.* 35, 563–581. doi: 10.1002/jcop.20165

Ma, H., Zhang, S. G., Yang, H. X., and Ren, L. (2022). Community sports participation dissolves loneliness: the role of sense of community and self-expression. *Community Psychol.* 13.

Mak, W. W. S., Cheung, R. Y. M., and Law, L. S. C. (2009). Sense of community in Hong Kong: relations with community-level characteristics and residents' well-being. *Am. J. Community Psychol.* 44, 80–92. doi: 10.1007/s10464-009-9242-z

McMillan, D. W. (1996). Sense of community. *Am. J. Community Psychol.* 24, 315–325.doi:10.1002/(SICI)1520-6629(199610)24:4<315::AID-JCOP2>3.0.CO;2-T

McMillan, D. W., and Chavis, D. M. (1986). Sense of community: a definition and theory. *Community Psychol.* 14, 6–23. doi: 10.1002/1520-6629(198601)14:1<6::AID-JCOP2290140103>3.0.CO;2-I

Millner, U. C., Woods, T., Furlong-Norman, K., Rogers, E. S., Rice, D., and Russinova, Z. (2019). Socially valued roles, self-determination, and community participation among individuals living with serious mental illnesses. *Am. J. Community Psychol.* 63, 32–45. doi: 10.1002/ajcp.12301

National Bureau of Statistics of China (2021). *Main Data of the Seventh National Population Census*. China: National Bureau of Statistics of China.

Nelson, B. D., Perlman, G., Klein, D. N., Kotov, R., and Hajcak, G. (2016). Blunted neural response to rewards as a prospective predictor of the development of depression in adolescent girls. *Am. J. Psychiatr.* 173, 1223–1230. doi: 10.1176/appi.ajp.2016.15121524

Nowell, B., and Boyd, N. (2010). Viewing community as responsibility as well as resource: deconstructing the theoretical roots of psychological sense of community. *J. Community Psychol.* 38, 828–841. doi: 10.1002/jcop.20398

Omoto, A. M., and Packard, C. D. (2016). The power of connections: psychological sense of community as a predictor of volunteerism. *J. Soc. Psychol.* 156, 272–290. doi: 10.1080/00224545.2015.1105777

Ren, Y. J., Tang, R., and Xiao, L. M. (2022). The effect of exercise identity on the psychological well-being of community-dwelling older adults: the moderating role of social support. *Chin. J. Clin. Psychol.* 30.

Sagy, S., Stern, E., and Krakover, S. (1996). Macro-and microlevel factors related to sense of community: the case of temporary neighborhoods in Israel. *Am. J. Community Psychol.* 24, 657–676. doi: 10.1007/BF02509719

Sarason, S. B. (1974). *The Psychological Sense of Community: Prospects for a Community Psychology*. San Francisco, CA: Jossey-Bass.

Scharlach, A., and Lehning, A. (2013). Aging-friendly communities and social inclusion in the United States. *Aging Soc.* 33, 110–136. doi: 10.1017/S0144686X12000578

Talò, C., Mannarini, T., and Rochira, A. (2014). Sense of community and community participation: a meta-analytic review. *Soc. Indic. Res.* 117, 1–28. doi: 10.1007/s11205-013-0347-2

Tovel, H., and Carmel, S. (2014). Maintaining successful aging: the role of coping patterns and resources. *J. Happiness Stud.* 15, 255–270. doi: 10.1007/s10902-013-9420-4

Wahl, H. W., Iwarsson, S., and Oswald, F. (2012). Aging well and the environment: toward an integrative model and research agenda for the future. *J. Gerontol.* 52, 306–316. doi: 10.1093/geront/gnr154

Wu, X. L., Luo, W., Ma, W. J., and An, C. (2010). Analysis of the correlation between self-efficacy and general well-being of medical students and discussion of the influencing factors. J. Chin. Med. *Educ. Res.* 9.

Xiao, S. Y. (1994). The theoretical basis and research application of social support rating scale. *J. Clin. Psychol.* 4, 98–100.

Yao, R. S., Guo, M. S., and Ye, H. S. (2018). Mechanisms of social support on the social well-being of older adults: the mediating role of hope and loneliness. *J. Psychol.* 50, 1151–1158.

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TYPE Original Research
PUBLISHED 12 January 2023
DOI 10.3389/fspor.2022.1003342

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SPECIALTY SECTION
This article was submitted to Movement Science and Sport Psychology, a section of the journal Frontiers in Sports and Active Living

RECEIVED 26 July 2022
ACCEPTED 28 December 2022
PUBLISHED 12 January 2023

CITATION
Yamaguchi S, Kawata Y, Murofushi Y and Ota T (2023) The influence of vulnerability on depression among Japanese university athletes. Front. Sports Act. Living 4:1003342. doi: 10.3389/fspor.2022.1003342

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The influence of vulnerability on depression among Japanese university athletes

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Objective: This study examined the estimated causal relationship between vulnerability and depressive symptoms in Japanese university athletes and how the degree of vulnerability affects depressive symptoms.
Materials and methods: In Study 1, 248 Japanese university athletes completed a continual survey from Time 1 to Time 3. In Study 2, 562 Japanese university athletes responded to another survey during the same period. Structural equation modeling was performed to estimate the causal relationship using the cross-lagged effects model for the three waves. Next, a binomial logistic regression analysis was performed to examine the influence of vulnerability on depression.
Results: Results of the cross-lagged effects model showed that all paths from vulnerability to depressive symptoms were significant, and all paths from depressive symptoms to vulnerability were not significant. Thus, vulnerability was the causative variable and depressive symptoms were the outcome variables within the causal relationship. The logistic regression results showed that those with high vulnerability were 1.7 times more likely to have moderate or higher depressive symptoms than those with low vulnerability. Vulnerable individuals are at a higher risk for developing depressive symptoms. By verifying the causal relationship between vulnerability and depressive symptoms, we can contribute to the enhancement of mental health care in accordance with the weakest link model. Appropriate psychological support for athletes can decrease depression and improve their mental health.

KEYWORDS

depression, Japanese university athletes, vulnerability, mental health, structural equation modeling

1. Introduction

Exercise and physical activity have a positive effect on mental health (1); however, this is not always the case for athletes, as there are instances in which stress factors distinctive to a competitive life impair athletes' mental health. Fatigue from training has also been shown to lead to mental health problems, such as depressive symptoms (2), burnout, eating disorders, and, in severe cases, suicide (3, 4). Depression is one of the leading causes of non-fatal health loss worldwide (5). The prevalence of depression among college athletes globally has been found to range from 15.6% to 21.0% (6), with several top athletes having reported that they suffer from serious depression (7). Thus, it is highly possible that the incidence of mental health problems, their severity, and the risk of developing symptoms have become serious challenges for athletes (8). However, not all athletes develop mental health problems. Some athletes can respond flexibly when faced with stressors (9). Conversely, people with a negative predisposition, such as those with a higher level of vulnerability, are more likely to display

maladaptation when faced with a stressful event than those with a more positive predisposition (10).

Several models of cognitive vulnerability to depression have been presented. Abela and Sarin (11) proposed the weakest link hypothesis, which examines the influence of multiple measures of cognitive vulnerability, postulating that a person's most maladaptive score on a set of indices is the best predictor of risk for depression. Individuals' overall propensity to depression may lie solely with their most vulnerable cognitive characteristics. Thus, indices of a person's average vulnerability may be relevant in predicting depression. Yamaguchi et al. (12) developed the weakest link model, focusing on athletes' vulnerability to explain the development of mental health problems among them. Vulnerability refers to a cognitive structure that is susceptible to stress (13) and is defined as "a susceptibility to damaging oneself, a possible state of brittle or emotional hurt" (14). According to this model, athletes with high levels of vulnerability may suffer damage to their mental health if they encounter an injury factor, which may worsen their competitive performance or even lead to a mental health disorder (12). In fact, vulnerable individuals are more likely to develop negative interpretations of an event when faced with stress factors, resulting in the development of depression (15, 16). Furthermore, people with a negative predisposition, for example, those with a higher level of vulnerability, are more likely to display maladaptation when faced with a stressful event than those with a more positive predisposition (10). Therefore, athletes' level of vulnerability can affect their level of psychological distress and pain.

Studies on vulnerability showed that women score significantly higher on vulnerability than men, indicating that they are more vulnerable (17). It has also been established that, compared to other students, freshmen are more vulnerable (18). In addition, a relationship between vulnerability and mental health (General Health Questionnaire) and depressive symptoms (self-rating depression scale) has been reported (12, 17). Moreover, positive correlations have been confirmed between stress vulnerability, anxiety symptoms, and depression symptoms in medical and humanities students (19). Furthermore, Satici (20) reported that vulnerability has a negative path of hope and well-being, and that high vulnerability leads to low wishful thinking and contributes to a decline in happiness. Therefore, the higher the vulnerability, the more the person's mental health would be impaired, and more depressive symptoms would be displayed. Since vulnerability is related to mental health symptoms, it is important to focus on an individual's vulnerability to prevent mental health disorders related thereto.

Research on this topic, thus far, has been limited to cross-sectional studies. Previous studies have clarified the correlation between factors related to vulnerability, but they have been unable to grasp the temporal precedence between these variables. Therefore, it has not yet been clarified whether depressive symptoms increase due to high vulnerability, or whether increased depressive symptoms lead to higher vulnerability. For example, when an athlete faces a stress factor, the athlete may be negatively affected by it and exhibit depressive symptoms. Conversely, when a stress factor is present, the athlete's depressive symptoms may increase, leading to further negative effects. The exact mechanism remains unclear. Cognitive theories of depression define vulnerability as an internal and stable feature of individuals that predisposes them to develop depression following the occurrence of negative events (21). According to Abela and Hankin (22), the higher an individual's level of cognitive vulnerability, the less stressful the negative event need to be to trigger the onset of depressive symptoms or episodes. Cognitive theorists have conducted considerable research on the relationship between vulnerability and depressive symptoms (23–25); however, no study has been conducted on "vulnerability" alone. In addition, research on vulnerability factors for athletes has not been conducted. Examining the causal relationship between vulnerability *per se* and depressive symptoms in athletes may contribute to the cognitive theory of vulnerability.

One of the methods for examining this relationship is an analytical approach, using a cross-lagged effects model (cross-lagged panel design), which is a statistical method that uses longitudinal data and analyzes a causal relationship after incorporating the possibility that two variables might affect each other in both directions (26). Previous studies on the causal relationship between vulnerability and depressive symptoms have assumed that depressive symptoms (stress response) were outcomes. However, it is important to clarify the causal relationship between the two variables using a cross-lagged effects model to confirm whether this assumption is correct. If we assume that depressive symptoms are the outcome variable caused by vulnerability, the relationship wherein "the higher the vulnerability, the more the depressive symptoms are exhibited," can be estimated. At this point, logistic regression analysis is considered useful as a test for examining the degree of depressive symptoms caused by vulnerability. Logistic regression analysis is a model used to predict probabilities by linking two-valued variables that represent the occurrence of events with multiple factors. As an example of analytical use, it is a statistical method widely used in various scientific fields (e.g., systems engineering and medicine) to examine, for example, the occurrence of diseases and the presence or absence of earthquakes. By using logistic regression analysis for the variables examined in this study, it would be possible to estimate the degree to which depressive symptoms are affected by an individual's vulnerability.

Previous studies have clarified the strength of the correlation between vulnerability and depressive symptoms (12, 27). A study conducted in the field of biological psychiatry reported that chronic social stress increases vulnerability (28). According to Ingram and Luxton (15), the route from vulnerability to disorder is explained by various versions of the vulnerability-stress model, as the way in which interactions between predisposing factors (vulnerabilities) and stress influence the development of a disorder. Furthermore, Zuroff et al. (29) inquired "whether vulnerable individuals merely describe themselves as being more self-critical or dependent, or whether they become more self-critical or dependent when they experience depressive symptoms." Therefore, the stressor is expected to increase an individual's vulnerability and, consequently, cause a stress response. However, while several studies have examined the relationship between vulnerability and stress responses, the aspect of causation is ignored. In fact, when considering the extent to which a vulnerable state affects stress responses, researchers regarded the stress response as the

dependent variable, and vulnerability was viewed as an intervening factor between the stressor and stress response. Thus, we believe that clarifying the temporal and causal relationships between these two variables can provide a novel perspective regarding the weakest link model and possibly help in developing an approach to provide increased early support to vulnerable people. If the cause-and-effect relationship—such as "when people are emotionally hurt, they experience increased depressive symptoms"—is identified, it will be possible to estimate the risk of developing depression, which will provide an opportunity to prevent mental health problems.

1.1. Purpose

To examine the effect of vulnerability on depressive symptoms, this study was divided into two parts—Study 1 aimed to elucidate the causal relationship between vulnerability and depressive symptoms, and Study 2 sought to examine the effect of vulnerability on depressive symptoms. The hypothesis of Study 1 is as follows:

H1: There is a causal relationship between vulnerability and depressive symptoms, of which depressive symptoms are the outcome.

The purpose of Study 2 was to examine the extent to which the degree of vulnerability affects depressive symptoms, using logistic regression. The hypothesis of Study 2 is as follows:

H2: The higher the score for vulnerability, the higher the risk of depressive symptoms occurring.

2. Study 1

2.1. Survey period

The survey period was divided into Time 1 (from mid-April to mid-May 2018), Time 2 (from late June to early July 2018), and Time 3 (October 2018).

2.2. Participants

A total of 248 university athletes (161 men and 87 women; average age = 19.0 years, $SD = 0.85$), completed the entire survey from Time 1 to Time 3. The participants were student athletes from university sports teams or sports clubs, who participated in competitions in the Kanto areas of Japan. Participants from 22 sports—including track and field, soccer, baseball, and basketball—who competed at international, national, and regional levels were included in this study. Athletes who participated for leisure or refreshment purposes were not included. Athletes who had developed injuries or illnesses or had left the club during the research period were excluded, as were staff. It is reported that the desirable sample size for model verification is 200 samples or more (30). In addition, although the sample size was 143 in the study using the cross-lagged model (31), the sample size in our study was set to about 200 in consideration of missing responses and non-participation in the longitudinal survey.

2.3. Method

The survey was administered through the group survey method, using a questionnaire. Once students had received the questionnaire, read the section related to ethical considerations on the cover page, and agreed to participate, they proceeded to respond to the questions. The completed questionnaires were collected immediately.

2.4. Ethical considerations

Before starting the survey, the participants were fully informed verbally and in writing that participation in the survey was voluntary, that they would not be disadvantaged if they did not participate, and that the results would be used solely for the purpose of this study. Participants provided informed consent prior to the study. This study was conducted with the approval of the institutional review board of the institution to which the first author belongs (No. 30-103).

2.5. Investigation

The contents of the questionnaire survey were as follows:

2.5.1. Basic attributes

As demographic data, we collected participant information regarding their gender, age, grade, and the sport types they participated in.

2.5.2. Athletic vulnerability scale

This scale was developed by Yamaguchi et al. (17) to measure athletes' vulnerability. It consists of 12 items with three factors: vulnerability toward low interpersonal evaluation, vulnerability toward unstable performance, and vulnerability toward denial or being ignored by others. Participants were to respond using a rating scale from 1 ("I completely disagree") to 4 ("I completely agree"). In this scale, the higher the score of vulnerability (easier to hurt the mind), the more likely it is to lead to mental health problems. The average score of all items was taken as the respondent's score on this scale.

2.5.3. Depression affinity self-evaluation scale

Zung's Self-Rating Depression Scale (32) was used to measure depressive symptoms. Participants responded on a four-point scale from 1 ("some of the time") to 4 ("most of the time"); the higher the score, the more likely the person is to be depressed.

2.6. Analytical method

An analysis of variance with correspondence was used to determine how vulnerability and depressive symptoms change over

time, based on measurements at three-time points. Next, a causal relationship was estimated, using a three-wave cross-delay-effect model. We specifically verified the cross-lagged effects model for three waves (Time 1, Time 2, and Time 3), using structural equation modeling. The comparative-fit index (CFI), goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI), and root-mean-square error of approximation (RMSEA) were used as indicators of the goodness of fit of the model. We used IBM's SPSS Statistics [IBM SPSS Statistics for Windows, version 28 (IBM Corp., Armonk, NY, United States)] and the Amos 28 software programs for data analyses.

2.7. Results

2.7.1. The causal relationship between vulnerability and depressive symptoms

The analysis of variance showed that vulnerabilities and depressive symptoms fluctuate over time. Vulnerability increased more during Time 3 than during Time 1 or Time 2. Depressive symptoms were higher in Time 1 than in Times 2 or 3 (**Table 1**).

Analysis by the cross-lagged effects model showed a significant relationship in the path of vulnerability in Time 1 to depressive symptoms, and vulnerability in Time 2 to depressive symptoms, showing a significant relationship between depressive symptoms and vulnerability in Time 1 (**Figure 1**). There was no significant difference between Time 2 and Time 3 for vulnerability and depressive symptoms. The model's goodness of fit was as follows: CFI = .98, GFI = .98, AGFI = .93, and RMSEA = .07.

3. Study 2

3.1. Survey period

The survey period was October 2018, the same as Time 3 in Study 1.

3.2. Participants

The participants were 562 athletes (376 men and 186 women; average age = 20.1 years, *SD* = 1.30), who belonged to a competitive athletic club or university in the Kanto area. Participants from Study 1 were not included. Participants from 21 individual sports and team sports—such as track and field, gymnastics, and soccer—who competed at international, national, local, prefectural, and district levels were included in this study.

3.3. Survey method

The survey method was the same as that for Study 1.

3.4. Ethical considerations

The ethical considerations were the same as those in Study 1.

3.5. Investigation

The questionnaires used were the same as those used for Study 1.

3.6. Analytical method

We investigated the effect of vulnerability on depressive symptoms. First, the descriptive statistics for each variable were calculated, and t-tests and analysis of variance were performed to clarify the confounding factors obtained from the demographic data. Subsequently, the degree of influence (odds ratio) on depressive symptoms was examined, based on the vulnerability score. The vulnerability score was classified as a median, two-valued variable (high group/low group), and taken as the independent variable, and the depressive symptom score was classified by the cutoff value of 47 points (33), which is considered as "moderately depressed." A binomial logistic regression analysis was performed with the two-valued variable as the dependent variable, and the confounding factors as the covariate. We used IBM's SPSS Statistics [IBM SPSS Statistics for Windows, version 28 (IBM Corp., Armonk, NY, United States)] software program for data analyses.

3.7. Results

3.7.1. Effects of vulnerability on depressive symptoms

The analysis revealed gender and age as confounding factors; women scored significantly higher on the vulnerability scale than men, and older people were shown to be more vulnerable than younger people. Based on these findings, the abovementioned confounding factors were captured as covariates in the logistic regression analysis.

The logistic regression analysis showed that when the low vulnerability group was 1.0, the high vulnerability group had a 1.7-

TABLE 1 Time-series basic data and results for vulnerability and depressive symptoms.

	Time 1	Time 2	Time 3	*F*-value	*p*-value	Multiple comparison
Vulnerability	2.6	2.6	2.7	10.47	.001***	1 < 3, $p < .01$ 2 < 3, $p < .001$
Depression	40.7	40.5	39.3	4.23	.05*	1 > 3, $p < .05$ 2 > 3, $p < .01$

*$p < .05$, ***$p < .001$.

fold increased risk of moderate or higher depression (Exp $\beta = 1.70$, 95% confidence interval = 1.02–2.83, $p < .05$; Table 2).

4. Discussion

The purpose of this study was to explore the causal relationship between vulnerability and depressive symptoms in Japanese university athletes, and to examine the effect of high vulnerability on depressive symptoms.

4.1. The causal relationship between vulnerability and depressive symptoms in Japanese university athletes

The cross-delayed effect model in Study 1 revealed that all paths from vulnerability to depressive symptoms were significant, and that all paths from depressive symptoms to vulnerability were not significant. Accordingly, it was possible to estimate the causal relationship between these variables. However, caution is needed with respect to the model's goodness of fit indices, which were.90 or higher for the CFI, GFI, and AGFI, and.07 for the RMSEA (34). While an RMSEA $\leq .06$ is considered acceptable (35), an RMSEA $\geq .10$ is not (36). Based on these criteria, although the CFI, GFI, and AGFI were within the reference values, the RMSEA was not sufficiently good. Therefore, increasing the number of participants and including more error correlations could improve the model's fit. However, we believe that such actions are arbitrary and not highly desirable. Based on Shi et al.'s (37) assertion that the model size has an important impact on the population values of CFI and RMSEA, in the present study, we postulated that increasing the number of participants would stabilize the fit of the model. Indeed, we found that the model size (p) significantly affected the population values of the CFI, TLI, and RMSEA. Even if the model fit exceeds the standard value, it may be possible to bring about a fit that falls within the standard value by increasing the sample size. Hence, it would be desirable to conduct a new survey instead of increasing the sample size arbitrarily. Therefore, based on this study's results, further investigation is recommended in future research. Regarding the estimation of causality using the cross-delayed effect model, no significant difference was found in any of the paths from depressive symptoms to vulnerability. Thus, the manifestation of depressive symptoms escalates when vulnerability increases. Previous studies dealing with vulnerability and depressive symptoms have treated depressive symptoms as outcomes due to vulnerability (12, 17, 33). From this, it has been reported that there is a positive relationship between vulnerability and mental health and depressive symptoms, and that the more vulnerable the person, the poorer the mental health. However, although causal relationships have not been estimated in those studies, more conclusive results were obtained in the current study by estimating the causal relationships. Vulnerable individuals display a negative interpretation of life events only when they are confronted with certain stressors, which places them at high risk for depression and other diverse negative outcomes (15). Moreover, when confronted with a new situation, a vulnerable person's first thought might be that they will fail at a newly learned task or they should avoid a new acquaintance (38). From this, it can be inferred that vulnerable people perceive events in a negative light, causing them to feel extra hurt, and as a result of that reaction, it leads to depressive symptoms and poor mental health.

TABLE 2 Results of the effects of vulnerability on depressive symptoms.

	β	Odds ratio	p-value	95% Confidence intervals	
Vulnerability	.522	1.704	.039*	1.027	2.825
Gender	.103	1.109	.704	0.651	1.890
Age	.002	1.002	.659	0.995	1.008
	−2.286	.102	.001		

*$p < .05$.

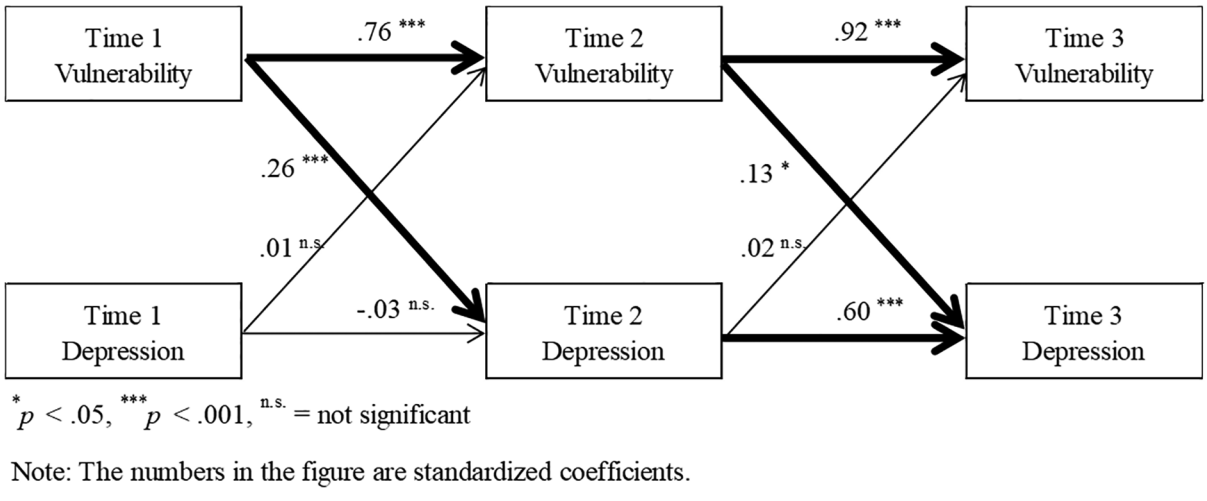

FIGURE 1
Estimated results of a causal relationship between vulnerability and depressive symptoms.

4.2. Effects of the degree of vulnerability on depressive symptoms

The logistic regression analysis was performed in Study 2, which showed that those with high vulnerability were 1.7 times more likely to develop depressive symptoms than those with low vulnerability. These facts support the hypothesis of this study: "the higher the score of vulnerability, the higher the risk of depressive symptoms." Based on the above results, we will subsequently discuss the causal relationship between vulnerability and depressive symptoms, and the effect of vulnerability on depressive symptoms. Regarding the effect of vulnerability on depressive symptoms, depressive symptoms were estimated as an outcome, caused by vulnerability in the previous cross-delayed effects model. Examining how different degrees of vulnerability affect depressive symptoms revealed that the group with high vulnerability was 1.7 times more likely to have depressive symptoms than the group with low vulnerability. In other words, those with high vulnerability were approximately twice as likely to develop depressive symptoms than those who were less vulnerable; this indicates that people with high vulnerability were at a higher risk of developing depression. Xiao et al. (39) evaluated vulnerabilities and depressive symptoms in Chinese university students using a hierarchical linear model analysis. Their results support the findings of this study, as it showed that those with high vulnerability scores have significantly more depressive symptoms than those with low vulnerability scores. Higher weakest link scores would be associated with greater increases in depressive symptoms following negative events (11, 40). According to Abela and Sarin (11), this provides support for operationalizing cognitive vulnerability to depression by utilizing a weakest link approach.

4.3. Vulnerability and depressive symptoms according to the weakest link model

Focusing on vulnerability, it is predicted that the degree of subsequent depressive symptoms will differ, depending on the degree of individual vulnerability. In fact, the degree of vulnerability differed from the results of the logistic regression analysis. Given these facts, we could demonstrate the psychology-based "weakest link model" proposed by Yamaguchi et al. (12). Originally, the weakest link model was outlined in engineering as follows: "when a chain is pulled, it begins to break at the weakest part of the chain and gradually collapses" (41, 42). Therefore, it shows that vulnerable people's mental health, which is initially good, is gradually damaged when their weak and fragile parts are attacked. For instance, if adolescents experience hurt as threatening, they recall it repeatedly, which leads to increased stress (43). This is exactly what the weakest link represents. Previous studies have examined the link between vulnerability and all stress responses. However, in most of those studies, researchers judged that vulnerability was the causative variable and stress response was the outcome. Since the path coefficient was significant and the model's goodness of fit was within the permissible range, as previously shown, causality could be inferred; it was appropriate to attribute causality to vulnerability, with depressive symptoms as the outcome. In other words, since vulnerability was the cause and depressive symptoms were the result, it was consequently suggested that vulnerability is associated with depressive symptoms, and that the higher the vulnerability score, the stronger its effect on depressive symptoms. From this, the weakest link model was proven, and it was found that when there is an event in which a person can easily be hurt, the person's mental health is more and more damaged from that incident. In addition, according to Abela and Sarin (11) who advocated the weakest link approach, their study revealed that participants' "weakest links" interacted with the occurrence of negative events to predict increases in depressive symptoms. This study has shown that vulnerability is the causative variable; therefore, we think that further research based on the weakest link will be necessary in the future.

Yamaguchi et al. (44) also examined the impact of mental health as an outcome of vulnerability and suggested that those with high vulnerability are approximately twice as likely to experience deteriorated mental health compared to those with low vulnerability. Therefore, it is conceivable that vulnerable people are more likely to experience poorer mental health. In terms of depressive symptoms and mental health, people who are easily hurt have poorer mental health, implying that early intervention for vulnerable individuals is important. For example, having a social network and team support is an effective way to prevent depression in college athletes (45). Amemiya and Sakairi (31) noted that teammates' support is important for athletes. When interpersonal problems arise due to excessive competition within the team, athletes are unable to receive sufficient support from their teammates, which functions as a stressor for interpersonal exhaustion. Furthermore, the persistence of such symptoms may cause more serious psychological problems (31). These findings demonstrate the importance of a functioning support system for athletes who are particularly vulnerable. According to Yamaguchi et al. (9), vulnerable athletes need to be provided with appropriate emotional support to cope with stressful situations, as they rely heavily on a stress management strategy for emotional regulation. For this reason, it is important to provide emotional and teammate-related support for vulnerable athletes. However, in competitive sports, wherein high performance is imperative, the susceptibility of individuals and the need for support may be perceived as "individual weakness." It has also been pointed out that excessive stress may lead to burnout and mental health problems (46). In both cases, a preventive approach is important. Hence, the findings of this study imply the need to prevent the development or progression of depressive symptoms in athletes, and this can be used to emphasize the promotion of support for maintaining good mental health. We think that it is important to understand mental health by considering a person's weakest link.

4.4. Limitations

This study has two limitations. The first concerns the timing of the survey. The survey was conducted at intervals of three months —that is, in April, July, and October. When conducting a longitudinal survey, it is preferable to have an interval of two to

three months. However, the month of April, in which the survey was first conducted, was the beginning of the new semester—a period of excessive vulnerability for some students. Regarding depressive symptoms, a significant difference was observed from Time 2 to Time 3. Therefore, it is possible that experiences of depressive symptoms are more likely to occur during autumn than in spring. Thus, setting the survey timing appropriately is seemingly important and must be taken into consideration.

The second limitation is the absence of stress responses other than depressive symptoms. In this study, depressive symptoms were defined as outcomes. However, psychological variables other than depressive symptoms that adversely affect mental health were predicted. In fact, Yamaguchi et al. (44) conducted research using mental health as an outcome and obtained similar results. Examining factors associated with depressive symptoms and other stress responses and vulnerability may help vulnerable athletes develop coping strategies for maintaining good mental health. Concomitantly, caution must be exercised when interpreting causality. We used a cross-delay effect model to try to estimate the causal relationship between vulnerability and depressive symptoms this time. A causal relationship was estimated only with the obtained data. Although the cause and effect relationship—that people who are easily hurt daily are more likely to develop depressive symptoms—has been confirmed, it is necessary to conduct interview surveys and examine the pathway from hurt to depression. However, further careful verification is necessary in the future.

Additionally, we included athletes who compete at various levels, ranging from international to local. Although an examination of the confounding factors in Study 1 did not reveal a significant difference, the degree of depressive symptoms may differ depending on the competition level. Therefore, future research should consider the differences between individual and group competitions, as well as those between each competition level.

Based on the above, we can expect the development of research that will focus on the prevention, maintenance, and improvement of athletes' mental health by considering and analyzing the issues listed above, as well as developing strategies to prevent depression.

5. Conclusion

In this study, we aimed to explore the causal relationship between vulnerability and depressive symptoms, and examine the effect of high vulnerability on depressive symptoms among Japanese university athletes. The results showed that all paths from vulnerability to depressive symptoms were significant, indicating that vulnerability is a causal factor for depression. Additionally, those with high vulnerability were 1.7 times more at risk of depressive symptoms by than those with low vulnerability. From the sport psychology perspective, understanding athletes' degree of vulnerability is important to prevent adverse effects on their mental health. This is expected to stimulate the development of research focused on preventing mental health problems, as well as maintaining and improving mental health. In the future, it will be necessary to develop mental health support for vulnerable people according to the weakest link model. In addition, regarding the fact—which was verified in this study—that depressive symptoms increase when one is emotionally hurt, it is important to conduct an interview survey to understand the pathway from emotional hurt to depressive symptoms.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author/s.

Ethics statement

The studies involving human participants were reviewed and approved by Faculty of Health and Sports Science, Juntendo University. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

SY designed this study, collected all the data, performed the statistical analysis, and prepared the manuscript. YK contributed to the study design and data collection. Other authors provided expert guidance for developing the scale according to their specialties (YM: sports medicine; TO: psychiatry). All authors contributed to the article and approved the submitted version.

Funding

This work was supported by the Joint Research Program of Juntendo University, Faculty of Health and Sports Science. This work was supported by JSPS KAKENHI (Grant Number: JP20K19517).

Acknowledgments

We would like to thank all the university athletes who participated in this study. Further, we would also like to extend gratitude to all the people involved in this research.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. Hamer M, Stamatakis E, Steptoe A. Dose-response relationship between physical activity and mental health: the Scottish health survey. *Br J Sports Med*. (2009) 43:1111–4. doi: 10.1136/bjsm.2008.046243

2. Cadegiani F. *Overtraining syndrome in athletes*. Cham: Springer (2020).

3. Peluso MAM, de Andrade LHSG. Physical activity and mental health: the association between exercise and mood. *Clinics*. (2005) 60:61–70. doi: 10.1590/s1807-59322005000100012

4. Sundgot-Borgen J, Torstveit MK. Prevalence of eating disorders in elite athletes is higher than in the general population. *Clin J Sport Med*. (2004) 14:25–32. doi: 10.1097/00042752-200401000-00005

5. James SL, Abate D, Abate KH, Abay SM, Abbafati C, Abbasi N, et al. Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990–2017: a systematic analysis for the global burden of disease study 2017. *Lancet*. (2018) 392:1789–858. doi: 10.1016/S0140-6736(18)32279-7

6. Proctor SL, Boan-Lenzo C. Prevalence of depressive symptoms in male intercollegiate student-athletes and nonathletes. *J Clin Sport Psychol*. (2010) 4:204–20. doi: 10.1123/jcsp.4.3.204

7. Baum AL. Suicide in athletes: a review and commentary. *Clin Sports Med*. (2005) 24:853–69. doi: 10.1016/j.csm.2005.06.006

8. Tahtinen RE, Shelley J, Morris R. Gaining perspectives: a scoping review of research assessing depressive symptoms in athletes. *Psychol Sport Exerc*. (2021) 54:101905. doi: 10.1016/j.psychsport.2021.101905

9. Yamaguchi S, Kawata Y, Murofushi Y, Shibata N, Ota T. Psychological vulnerability associated with stress coping strategies in Japanese University athletes. *J Clin Sport Psychol*. (2022) 1(aop):1–15. doi: 10.1123/jcsp.2021-0084

10. Ishizu K, Ambo H. Vulnerability factors for school stress among junior high school students: over-adaptation and evaluation of emotion. *Japanese J Educ Psychol*. (2013) 84 (2):130–7. doi: 10.4992/jjpsy.84.130

11. Abela JR, Sarin S. Cognitive vulnerability to hopelessness depression: a chain is only as strong as its weakest link. *Cognit Ther Res*. (2002) 26(6):811–29. doi: 10.1023/A:1021245618183

12. Yamaguchi S, Kawata Y, Kaneko Y, Nakamura M, Shibata N, Hirosawa M. Relationship between vulnerability and depression among Japanese University athletes. *Juntendo Med J*. (2018) 64(1):60–3. doi: 10.14789/jmj.2018.64.JMJ18-P31

13. Sinclair VG, Wallston KA. The development and validation of the psychological vulnerability scale. *Cognit Ther Res*. (1999) 23(2):119–29. doi: 10.1023/A:1018770926615

14. Hayashi K. A study of vulnerability (Kizutsukiyasusa Nitsuiteno Ichikousatsu). *Mem Shiraume Gakuen Coll*. (2002) 38:1–10 (In Japanese).

15. Ingram RE, Luxton DD. Vulnerability-stress models. In: BL Hankin, JRZ Abela, editors. *Development of psychopathology: A vulnerability-stress perspective*. Thousand Oaks, CA: Sage Publications (2005). p. 32–46.

16. Monroe SM, Simons AD. Diathesis-stress theories in the context of life stress research: implications for the depressive disorders. *Psychol Bull*. (1991) 110:406–25. doi: 10.1037/0033-2909.110.3.406

17. Yamaguchi S, Kawata Y, Nakamura M, Hirosawa M, Shibata N. Development of the athletic vulnerability scale: an examination of vulnerability among university athletes and related factors. *Juntendo Med J*. (2019) 65:136–48. doi: 10.14789/jmj.2019.65.JMJ18-OA14

18. Nogueira MJ, Sequeira C, Sampaio F. Gender differences in mental health, academic life satisfaction and psychological vulnerability in a sample of college freshmen: a cross-sectional study. *J Gend Stud*. (2021) 31(8):1–10. doi: 10.1080/09589236.2021.1979945

19. Bunevicius A, Katkute A, Bunevicius R. Symptoms of anxiety and depression in medical students and in humanities students: relationship with big-five personality dimensions and vulnerability to stress. *Int J Soc Psychiatry*. (2008) 54(6):494–501. doi: 10.1177/0020764008090843

20. Satici SA. Psychological vulnerability, resilience, and subjective well-being: the mediating role of hope. *Pers Individ Differ*. (2016) 102:68–73. doi: 10.1016/j.paid.2016.06.057

21. Ingram RE, Miranda J, Segal ZV. *Cognitive vulnerability to depression*. New York: Guilford Press (1998).

22. Abela JR, Hankin BL. *Cognitive vulnerability to depression in children and adolescents: A developmental psychopathology perspective*. New York: The Guilford Press (2008).

23. Abramson LY, Seligman MEP, Teasdale J. Learned helplessness in humans: critique and reformulation. *J Abnorm Psychol*. (1978) 87:49–74. doi: 10.1037/0021-843X.87.1.49

24. Beck AT. *Depression: Clinical, experimental, and theoretical aspects*. New York: Harper & Row (1967).

25. Blatt SJ, Zuroff DC. Interpersonal relatedness and self-definition: two prototypes for depression. *Clin Psychol Rev*. (1992) 12:527–62. doi: 10.1016/0272-7358(92)90070-O

26. Finkel SE. *Causal analysis with panel data*. Thousand Oaks, CA: Sage Publications (1995).

27. Hankin BL, Abramson LY. Measuring cognitive vulnerability to depression in adolescence: reliability, validity, and gender differences. *J Clin Child Adolesc Psychol*. (2002) 31(4):491–504. doi: 10.1207/S15374424JCCP3104_8

28. Zhang Y, Lu W, Wang Z, Zhang R, Xie Y, Guo S, et al. Reduced neuronal cAMP in the nucleus accumbens damages blood-brain barrier integrity and promotes stress vulnerability. *Biol Psychiatry*. (2020) 87(6):526–37. doi: 10.1016/j.biopsych.2019.09.027

29. Zuroff DC, Mongrain M, Santor DA. Conceptualizing and measuring personality vulnerability to depression: comment on Coyne and Whiffen (1995). *Psychol Bull*. (2004) 130(3):489–511. doi: 10.1037/0033-2909.130.3.489

30. Iacobucci D. Structural equations modeling: fit indices, sample size, and advanced topics. *J Consum Psychol*. (2010) 20(1):90–8. doi: 10.1016/j.jcps.2009.09.003

31. Amemiya R, Sakairi Y. Examining the relationship between depression and the progression of burnout among Japanese athletes 1, 2. *Jpn Psychol Res*. (2022) 64 (4):373–84. doi: 10.1111/jpr.12332

32. Zung WWK. A self-rating depression scale. *Arch Gen Psychiatry*. (1965) 12:63–70. doi: 10.1001/archpsyc.1965.01720310065008

33. Zung WWK. The depression status inventory: an adjunct to the self-rating depression scale. *J Clin Psychol*. (1972) 28(4):539–43. doi: 10.1002/1097-4679(197210)28:4<539::AID-JCLP2270280427>3.0.CO;2-S

34. Toyoda H. *Covariance structure analysis (amons version)*. Tokyo: Tokyo Books (2007).

35. Hu LT, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct Equ Modeling*. (1999) 6(1):1–55. doi: 10.1080/10705519909540118

36. Browne MW, Cudeck R. Alternative ways of assessing model fit. In: KA Bolen, JS Long, editors. *Testing structural equation models*. Newbury Park, CA: Sage (1993). p. 136–62.

37. Shi D, Lee T, Maydeu-Olivares A. Understanding the model size effect on SEM fit indices. *Educ Psychol Meas*. (2019) 79(2):310–34. doi: 10.1177/0013164418783

38. Beevers CG. Cognitive vulnerability to depression: a dual process model. *Clin Psychol Rev*. (2005) 25(7):975–1002. doi: 10.1016/j.cpr.2005.03.003

39. Xiao J, Qiu Y, He Y, Cui L, Auerbach RP, McWhinnie CM, et al. "Weakest link" as a cognitive vulnerability within the hopelessness theory of depression in Chinese university students. *Stress Health*. (2016) 32:20–7. doi: 10.1002/smi.2571

40. Abela JR, McGirr A. Operationalizing cognitive vulnerability and stress from the perspective of the hopelessness theory: a multi-wave longitudinal study of children of affectively ill parents. *Br J Clin Psychol*. (2007) 46(4):377–95. doi: 10.1348/014466507X192023

41. Weibull W. A statistical distribution function of wide applicability. *J Appl Mech*. (1951) 18(3):293–7. doi: 10.1115/1.4010337

42. Weibull W. A statistical theory of strength of materials. Generalstabens Litografiska Anstalts Förlag, Stockholm. *Mod Mech Eng*. (1939) 6(4).

43. Joseph S, Williams R. Understanding posttraumatic stress: theory, reflections, context and future. *Behav Cogn Psychother*. (2005) 33:423–41. doi: 10.1017/S1352465805002328

44. Yamaguchi S, Kawata Y, Noguri R, Murofushi Y, Ota T. Effect of vulnerability on mental health among university athletes. *Jpn J Appl Psychol*. (2022) 65:136–48. doi: 10.24651/oushinken.47.3_209

45. Armstrong S, Oomen-Early J. Social connectedness, self-esteem, and depression symptomatology among collegiate athletes versus nonathletes. *J Am Coll Health*. (2009) 57:521–6. doi: 10.3200/JACH.57.5.521-526

46. Hägglund K, Kenttä G, Thelwell R, Wagstaff CR. Is there an upside of vulnerability in sport? A mindfulness approach applied in the pursuit of psychological strength. *J Sport Psychol Action*. (2019) 10(4):220–6. doi: 10.1080/21520704.2018.1549642

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 17 January 2023
DOI 10.3389/fpsyg.2022.1112308

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OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Personality and Social Psychology, a section of the journal Frontiers in Psychology

RECEIVED 30 November 2022
ACCEPTED 13 December 2022
PUBLISHED 17 January 2023

CITATION
Cabaco AS, Wöbbeking Sánchez M, Mejía-Ramírez M, Urchaga-Litago JD, Castillo-Riedel E and Bonete-López B (2023) Mediation effects of cognitive, physical, and motivational reserves on cognitive performance in older people.
Front. Psychol. 13:1112308.
doi: 10.3389/fpsyg.2022.1112308

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Mediation effects of cognitive, physical, and motivational reserves on cognitive performance in older people

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Introduction: We study from a multidimensional perspective the different factors that help prevent the development of cognitive impairment in old aging.

Methods: This study analyzed in 300 elderly subjects the relationship between cognitive reserve (CR), physical reserve (PR) and motivational reserve (MR) with cognitive impairment. This study also takes into consideration different variables (sex, age, educational level, and institutionalization) that might affect the results in the different types of reserves (CR, physical and MR) and cognitive impairment.

Results: The results show that people with a higher cognitive reserve, physical reserve and motivational reserve have less cognitive impairment.

Discussion: Therefore, it is important to consider measuring the CR as a variable to diagnose neurodegenerative illnesses but it is also essential to consider the physical state and physical activity, as well as the motivational dimension. With the cognitive reserve and sex variables no significant differences were observed. Age had a negative effect on strategic flexibility, but those with higher CR had better cognitive flexibility and the educational.

KEYWORDS

cognitive reserve, physical reserve, motivational reserve, cognitive impairment, age, educational level

Introduction

The increase in life expectancy all over the world has proven that the older person's demographic continues to grow with time (Jiménez et al., 2021). The World Health Organization (World Health Organization, 2021) states that people are living longer than ever before, this is something that is being experienced all over the world, not only has the quantity of older people increased but also the proportion of older people in relation to the

general population. This will become more evident between the years 2020 and 2050, when it is estimated that the number of people aged 80 and over will triple in size until it reaches 426 million in population. Aging occurs as a result of high accumulation of cellular and molecular damage over the years, which produces a progressive decrease in physical and mental capabilities, increasing the risk of developing an illness and eventually death. Although these changes occur with aging, they are not uniform nor linear, and their relation with a person's age is quite relative (World Health Organization, 2021). In this sense, as Barba (2021) stated, due to the increase in life expectancy, there has been a significant increase in age-related diseases, both physical and neuropsychological. Therefore, due to these demographic changes it is imperative to be prepared and attend aging in a multidisciplinary manner (Ochoa-Vázquez et al., 2019).

Currently there are various indicators that have a protective role in the presence of cognitive impairment, that favors a healthy and active aging process. Firstly, the cognitive reserve (CR) defined by Stern (2002) as the organism's ability to resist brain deterioration without presenting symptoms. According to this variable, people with a higher cognitive reserve have a lower risk and vulnerability of suffering a degenerative pathological process in cognitive impairment in old age. The current research based on active CR models suggests that there are several variables that influence its development, maintenance and enhancement throughout life. Although currently there is no existing evidence that suggests the relevance of each of the components, as well as the most appropriate combination of the measure, for its operationalization variables such as employment, education and leisure activities have been used: physical, mental and social, which have been the most used obtaining conclusive results (Barba, 2021).

The cognitive reserve hypothesis tries to explain the individual differences in regard to the vulnerability due to brain changes related to age or illness (Stern, 2005). It is thought that positive influences throughout life (better education or higher level of literacy) increase the efficacy of cognitive processes in aging (Stern, 2009). Although there is much literature on cognitive cues, there is not much evidence on the influence of emotional or motivational cues in delaying cognitive impairment. Thus, in a recent work by Guerrini and her team (Guerrini et al., 2022), they address the relation of cognitive reserve as being a key in emotion recognition, that is, the ability to interpret and combine social cues within different sensory systems. The results show the importance of cognitive reserve in executive functioning (assessed through Stroop test) but not in improving scores related to emotional performance (emotional recognition through faces or voices). Therefore, it would seem that in light of these results, cognitive reserve indicators are good predictors of cognitive task performance, although not being as effective in social cognition tests.

The cognitive reserve model that underlines the approach of this research refers to the dimension of resilience in the presence of damage or pathology, and also to cognitive decline or deterioration associated with age (Stern and Barulli, 2019). It is understood that the dichotomy between cognitive and cerebral reserve is not defensible given the empirical evidence of the close relationship between the two from the neurophysiological level (Barulli and Stern, 2013). In the same way, the differences are not shared with other constructs such as brain maintenance (Opdebeeck et al., 2016), because they are based on similar key aspects (education, cognitive stimulation or social contact). The operationalization of our proposal broadens the initial horizon of cognitive reserve (Stern, 2002) because it is supported by the high correlation between cognitive reserve and environmental enrichment, resulting in physical and mental activity as moderator variables of brain deterioration (Nithianantharajah and Hannan, 2009). The cognitive reserve construct that integrates the most empirically validated formulation refers to a combination of resistance capacity (brain processes in the face of pathology) and resilience (coping in terms of cognitive performance), which would integrate the concepts of cognitive reserve and brain maintenance, previously separated artificially (Arenaza-Urquijo and Vemuri, 2018). In this explanatory framework of cognitive reserve as a resilient mechanism, the approach can be understood associating it with physical and motivational reserves. There is more evidence of the association with the physical reserve (Cheng, 2016), while studies that relate to motivational keys of meaning are more recent (Bartrés-Faz et al., 2018), and scarce in its three-dimensional vision (Wobbeking et al., 2021).

Secondly, physical activity in elderly people is a key and favorable element of a healthy lifestyle, since both exercise and sport are effective in preventing, treating and recovering from the presence of certain diseases (Aldas et al., 2021). Doing exercise benefits people in their physical and mental development, by being a factor that protects, promotes and maintains good health, quality of life and wellbeing. The World Health Organization, (2020) defines physical activity as the body movements generated by skeletal muscles that consume energy. Therefore, physical activity refers to all movements to or from a particular place or as part of work, or even during your leisure time.

Physical exercise has a positive effect on most of the physical and psycho-social functions of the older people. For this reason, regular physical exercise adapted for the older population is the best non-pharmacological therapy against the main illnesses associated with the aging process (Martínez et al., 2021). Not only does physical activity benefit physical aspects, but also emotional ones like self-esteem, it decreases depressive symptoms, it improves social relationships and helps delay cognitive decline. Due to all these elements, carrying out physical activity makes it possible for the person to decrease the moments of sedentary lifestyle since it is considered one of the greatest risk factors for developing heart disease and death, since evidence shows there is a direct relation between a sedentary lifestyle, physical inactivity and cardiovascular mortality (Rodríguez et al., 2020). These data coincide with those carried out in a bibliographic review in the last year by Martínez et al. (2021). The results show that daily practice of physical activity improves self-esteem and has a positive effect

on happiness, in addition to favoring the capacity for self-care, improving the integration of the body scheme and facilitating intergenerational relationships.

Lastly, the motivational reserve (MR) stands out. Human motivation explains why people behave in a certain way. It involves affective, cognitive and learning components (Petri and Govern, 2021). A person with a high intrinsic motivation behaves in a direct, consistent and stable manner (Deci and Ryan, 1985). In older people, the meaning of life is especially important as a motivational factor (Pinquart, 2002). In addition, we also have to consider the positive effects and all the human strengths as part of the motivational aspects (Reich et al., 2004) that have been appropriate and developed, among which is worth highlighting the values and vital goals (Park et al., 2004; Peterson and Seligman, 2004). In older people, numerous studies have shown that having a better perspective on one's own meaning of life is related to better psychosocial health, physical well-being, a lower risk of mortality and depression, less loneliness, more optimism and more allostatic load (Zilioli et al., 2015; Cohen et al., 2016; Steptoe and Fancourt, 2019; Kim et al., 2020, 2022).

The meaning of life is positively correlated with character strengths, which are also related to a better life satisfaction and happiness, better physical health and lower anxiety and depression (Kim et al., 2013; Proyer et al., 2013; Niemiec, 2014; Steptoe, 2019; Trudel-Fitzgerald et al., 2019; Weziak-Bialowolska et al., 2021).

Therefore, the motivational reserve built throughout life has been found to influence the psychological well-being and quality of life in older people, which include CR and physical well-being.

The originality provided by the main objective of this study is to separately analyze the three components that in the cognitive reserve literature show controversies in the results and relation between: cognitive dimensions, physical activity and motivational cues. This research is a continuation of a previous study (Wobbeking et al., 2021) in which components associated with some types of reserve (physical and motivational) have been operationalized through a model of structural equations. This study provides evidence of the mediation effects of four sociodemographic predictors (age, educational level, sex and institutionalization) of cognitive performance contrasted with the three types of reserve (cognitive, physical and motivational) as mediating variables. This proposed model (Figure 1) hypothesizes that cognitive, physical, and motivational reserves are predictors of cognitive decline, as are the sociodemographic variables age, educational level, gender, and institutionalization. Cognitive impairment is the dependent variable in this model.

Materials and methods

Participants

The total sample consisted of 300 subjects: 224 women (75%) and 76 men (25%), in which 150 subjects live in institutionalized centers and 150 subjects live autonomously. The total sample consisted of subjects between the ages of 55 and 99 years, with a mean age of 74.66 for men and 74.70 for women, with a total mean age of 74.68 years. In regard to the institutionalized subjects, there were 107 women (71%) and 43 men (29%), between the ages of 55 years and 99 years, and whose mean age is 83.17 years. The subjects that were not institutionalized comprised a total of 117 women (78%) and 33 men (22%) between the ages of 55 years and 84 years, with a mean age of 66.21 years. The educational level for the total sample, 10% of the subjects have not had any type of education, being very close to illiteracy, 51% had primary education, 20% had secondary education and 19% had a higher education.

The inclusion criteria used were the same for both, firstly, being 55 years or older, having no symptoms of cognitive impairment and being institutionalized in a residential center or living at home.

Instruments

The evaluation battery used has been a sociodemographic data sheet that includes information on the older people, such as sex, age, educational level and institutionalized center, if they belong to the subsample. And the battery of tests with the following questionnaires are answered without a time limit: *Cognitive Reserve Questionnaire* (*CRQ*; Rami et al., 2011). This test evaluates the cognitive reserve through a series of variables (8 variables), like the subjects educational level, training courses, the education of the parents and work occupation, musical training and language proficiency. It also measures the frequency of stimulating activities carried throughout life such as intellectual games and reading. The study shows an acceptable reliability (Cronbach's Alpha: 0.72) and there is evidence of its validity.

Cognitive Reserve Scale (*CRS*; León et al., 2015). It is used to estimate the cognitive reserve in the Spanish population. It has a good reliability index (Cronbach's Alpha: 0.80) and evidence of good validity (León et al., 2017). This scale consists of 24 items and is divided into four areas: activities of daily living, training and information, hobbies and interests, and social life.

Montreal Cognitive Assessment (*MoCA*; Nasreddine et al., 2005). This test was developed as a brief screening tool to detect mild cognitive impairment. It measures various cognitive domains such as visuospatial abilities, memory, language and attention. This scale consists of 13 subtests. The approximate time to administer the MoCa test is 15 min and the maximum score possible is 30 points, with a cutoff score equal to 26 points or above to signify absence of cognitive impairment. For Spain's older adults population, this test has shown a good reliability (Cronbach's Alpha: 0.77) and there is evidence of its validity (Lozano et al., 2019).

Memory Alteration Test (*M@T*; Rami et al., 2007). This is a validated screening test for amnesic-type mild cognitive impairment and for mild Alzheimer's disease. This global memory screening test is made up of five subtests: encoding,

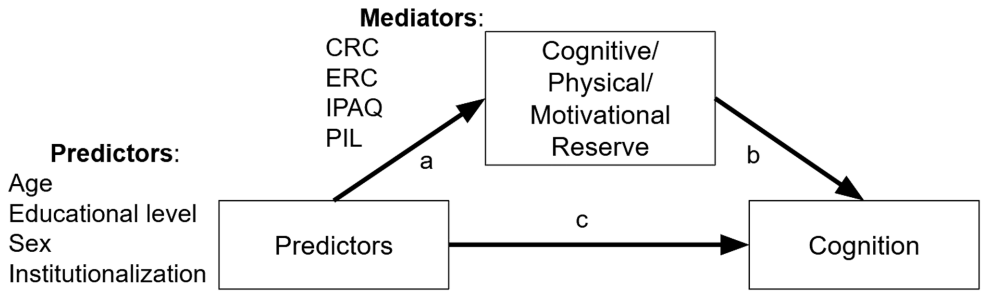

FIGURE 1
Structure of the mediation analyses tested. For each predictor (sociodemographic variables: age, education level, sex, institutionalization), we tested if their effect on cognition (measured with MoCA and M@T) was mediated by cognitive (CRQ, CRS scores), physical (IPAQ scores) and motivational (PIL scores) reserves. MoCA, Montreal Cognitive Assessment; M@T, Memory Alteration Test; CRQ, Cognitive Reserve Questionnaire; CRS, Cognitive Reserve Scale; IPAQ, International Physical Activity Questionnaire; PIL, Purpose in Life questionnaire.

temporal orientation, semantic memory, free recall and facilitated recall. This test has 38 items and shows an excellent reliability (Cronbach's Alpha: 0.92) and there is evidence of its validity. The maximum score possible is 50 points and the approximate time to administer the test in healthy subjects is 10 min. This test has been validated by numerous studies (Rami, 2009; Ozer et al., 2016) and in other countries like Portugal (Sousa, 2015). This test has a sensitivity of 96% in the 37 cutoff points, and a specificity of 70% to differentiate between subjects with mild cognitive impairment with subjective memory complaints.

International Physical Activity Questionnaire (IPAQ). This questionnaire was developed by World Health Organization (2012) and is made up of seven items in which the responses are quantified by the number of minutes or hours of activity practice, as indicated by each item. The reliability of the IPAQ in its short version (9 items) is 0.65 (rs = 0.76;CI95%:0.73–0.77; Craig et al., 2003). This scale helps obtain data related to physical activity associated with health and has currently been used with older people.

Purpose In Life (PIL). An attitude test designed by Crumbaugh and Maholick (1964) (Martínez et al., 2012) to quantify the degree to which the individual experiences that his life has meaning and purpose, as well as existential emptiness. This test is currently the most widely used instrument in research on the meaning of life due to the high internal consistency in all cases greater than 0.80 Cronbach's Alpha obtained in numerous studies with different populations (Cohen et al., 2016). This test consists of 20 items, in which the subjects must individually answer questions using a Likert-type scale from 1 to 7 between two extreme feelings. The highest score possible for the PIL is 140, for its interpretation the following criteria have been used (Crumbaugh and Maholick, 1969): scores below 90 would mean a clear lack of meaning, scores between 90 and 105 would show a lack of definition regarding the meaning of life, while scores above 105 would indicate the clear presence of meaning in life. This criteria is used in general for the entire Spanish population. Therefore, the higher the score, the greater the meaning of life.

Procedure

For this research, two stages were established. First, the centers were contacted in order to recruit the sample, both from the self-employed and institutionalized categories. The first group (non-institutionalized subjects) consisted of students from Experience University, Pontifical University of Salamanca and the SABIEX Program of the University of Miguel Hernández de Elche. These university programs for seniors are based on lifelong learning models. These training programs for the elderly are carried out in the university context, and are established in all the universities in Spain, but they are very heterogeneous among themselves, but in general they do not usually have a specific admission criteria criteria, except for age, and their objective to offer new knowledge, creating social media networks and participating in intergenerational relationships. The purpose is not to obtain a university degree, but rather to improve the quality of life of the elderly (Sitges, 2019).

The second group (institutionalized subjects) were recruited from multiple residential centers in the Autonomous Communities of Castilla, León and Valencia (Spain), in order to maintain the same contextual characteristics as the first group. The justification for using a dichotomized sample in autonomous and institutionalized older adults is based on the objective of offering a broader insight of the types of reserves evaluated, since in previous works they had been carried out in one condition or another. Since environmental enrichment is key to cognitive reserve, variations in the two habitat conditions are relevant to discriminate (Adam et al., 2013; Chapko, 2018; Lavrencic et al., 2018). In addition, due to the differential characteristics of the lifestyles in both contexts, a large difference can be predicted in the physical activity variable, a relevant factor in cognitive reserve, as has been pointed out (Cheng, 2016). We must also take note of the differential role in terms of life project and performance of significant life activities that both contexts enable and reinforce (Pettigrew and Soldan, 2019).

Secondly, the battery of tests was applied. The administration of these tests was carried out individually, lasting approximately

an hour and a quarter with each subject. The evaluation period was carried out between the months of March and October, and in all cases informed consent for participation was previously collected. In addition, this study has strictly complied with the ethical criteria indicated in the Declaration of Helsinki (revised in 2013) for research of this type. Finally, as inclusion criteria, in addition to accepting the indicated conditions (voluntariness to participate, present legal authorization and waiver of remuneration), the participants could not present any cognitive impairment. Failure to meet any of the above criteria were grounds for exclusion.

Data analysis

We built mediation analyses testing each possible mediator of cognitive, physical and motivational reserve on cognitive scores (MoCA) as the dependent variable. The predictors were age, educational level, sex, and institutionalization. Cognitive reserve was analyzed using both CRQ, and CRS scores. Physical reserve was analyzed with IPAQ scores, and motivational reserve was analyzed with PIL scores. For each predictor and mediator, we present unstandardized scores, and *p* values using the Sobel test for mediation analyzed in the Lavaan package in R.

The mediation analysis is presented using sociodemographic variables of age, sex, educational level and institutionalization as predictors. Cognitive reserve was assessed using the Cognitive Reserve Questionnaire and the Cognitive Reserve Scale, for the physical reserve the International Physical Activity Questionnaire was used, in which previous studies have found relevance in cognitive aging. The indirect motivational reserve was assessed using the Purpose in Life Questionnaire, and the cognitive performance was assessed with the MoCA test. If the indirect effect (column "a*b" in Tables 1–4) had greater weight than the direct effect (column "c"), this would mean that motivational reserve is an important mediating factor, beyond the mentioned variables.

Figure 1 shows the structure of the mediations that were analyzed. We used the convention of testing the significance of the direct effect (c), and of the indirect effect (a*b), and we considered that there was an effect of the mediator over the dependent variable when the indirect effect was statistically significant ($p < 0.05$). Therefore, we considered both complete and partial mediations of the cognitive (CRQ, CRS scores), physical (IPAQ scores) and motivational (PIL scores) reserves.

Results

Cognitive reserve

The summary of the direct, indirect, and total effects of age, educational level, sex and institutionalization on cognition, with cognitive reserve as mediator, is presented in Table 1. All four sociodemographic variables had statistically significant total effects, which indicates that they were predictors of cognition measured by MoCA and M@T.

In the case of age, there was a significant and negative mediation effect of cognitive reserve, with both Cognitive Reserve Questionnaire and Cognitive Reserve Scale scores, on cognition. The direct effect remained significant and was negative, indicating that overall, age had a negative correlation with cognition, whereas age increased, MoCA/M@T scores decreased. Looking at the indirect effect, the relation between age and Cognitive Reserve Questionnaire and Cognitive Reserve Scale scores was negative, which explains why, even though cognitive reserve has a positive relation with cognition, the overall effect of age was still negative. The mediation proportion was between a third (CRS scores) and a half (CRQ scores) of the total effect.

In the case of educational level, there was a significant and positive mediation effect of cognitive reserve with both Cognitive Reserve Questionnaire and Cognitive Reserve Scale scores. Interestingly, the direct effect remained significant only in the CRS scores. With CRQ scores, the mediation proportion was even larger than a 100% of the total effect. The effects of educational level on cognitive reserve (both CRQ and CRS scores), and of cognitive reserve on cognition, were positive, therefore, the overall indirect effect was also positive, indicating that the higher educational level, the higher the MoCA scores.

Sex had no significant indirect effect through cognitive reserve on cognition, with either Cognitive Reserve Questionnaire and Cognitive Reserve Scale scores. Nevertheless, there was a statistically significant positive effect of cognitive reserve on cognition, after controlling for the direct effect of sex. These results indicate that cognitive reserve did not depend on the sex of the participants, but cognition did varied with cognitive reserve levels.

Institutionalization showed a similar pattern as age, but these indirect effects are more difficult to interpret, given that institutionalized older adults had higher ages. The mediation proportion was a bit higher than that of age, 40% (CRS scores) and 57% (CRQ scores) for each type of measure of cognitive reserve.

Overall, cognitive reserve mediated the effects of age, educational level and institutionalization on cognition. In all cases, cognitive reserve had a positive effect on cognition, which was summed to the negative effect of age and institutionalization, and the positive effect of educational level.

Physical reserve

The summary of the direct, indirect, and total effects of age, educational level, sex, and institutionalization on cognition, with physical reserve as mediator, is presented in Table 2. Age, educational level and institutionalization, but not sex, showed statistically significant total effects, which indicates that they were predictors of cognition measured by MoCA and M@T.

TABLE 1 Mediation analysis of the four sociodemographic predictors of cognitive performance (assessed with MoCA and M@T) contrasted with cognitive reserve as a mediating variable (assessed with CRQ and CRS).

	Indirect effect				Direct effect	Total effect
	a	b	a*b	Prop.	c	(a*b)+c
CRQ→MoCA						
Age	−0.201***	0.495***	−0.100***	0.47	−0.111***	−0.211***
Education	4.084***	0.677***	2.764***	1.12	−0.300	2.465***
Sex (Women)	−0.485	0.625 ***	−0.303	0.27	−0.832*	−1.134*
Institutionalization	−5.973***	0.477***	−2.847***	0.57	−2.153***	−5.000***
CRS→MoCA						
Age	−0.593***	0.127***	−0.075***	0.36	−0.136***	−0.211***
Education	8.465***	0.129***	1.093***	0.44	1.371***	2.465***
Sex (Women)	2.709	0.185***	0.501	0.44	−1.636***	−1.134*
Institutionalization	−19.26***	0.104***	−2.006***	0.40	−2.994***	−5.000***
CRQ→M@T						
Age	−0.201***	0.930***	−0.187***	0.40	−0.282***	−0.470***
Education	4.084***	1.209***	4.937***	0.93	0.364	5.300***
Sex (Women)	−0.485	1.265***	−0.613	0.51	−0.587	−1.200
Institutionalization	−5.973***	0.752***	−4.495***	0.38	−7.298***	−11.79 3***
CRS→M@T						
Age	−0.593***	0.258***	−0.153***	0.33	−0.317***	−0.470***
Education	8.453***	0.269***	2.276***	0.43	3.024***	5.300***
Sex (Women)	2.744	0.389***	1.067	0.89	−2.268**	−1.200
Institutionalization	−19.278***	0.162***	−3.120***	0.26	−8.673***	−11.79 3***

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. The indirect effect is evaluated from the effect of the predictor on the mediating variable (a), and in turn from the mediating variable on cognitive performance (b). The indirect effect is reported by multiplying the two previous coefficients (a*b). The direct effect is the coefficient obtained directly from each predictor on the cognitive performance score (c).

TABLE 2 Mediation analysis of the four sociodemographic predictors of cognitive performance (assessed with the MoCA and M@T) contrasted with physical reserve as a mediating variable (assessed with the IPAQ).

	Indirect effect				Direct effect	Total effect
	a	b	a*b	Prop.	c	(a*b)+c
MoCA						
Age	0.014***	−1.294***	−0.018**	0.09	−0.193***	−0.211***
Education	−0.286***	−0.975**	0.279**	0.11	2.186***	2.465***
Sex (Women)	0.098	−1.811***	−0.177	0.16	−0.957	−1.134*
Institutionalization	0.440***	−1.012***	−0.445**	0.09	−4.555***	−5.000***
M@T						
Age	0.014***	−2.652***	−0.036**	0.08	−0.434***	−0.470***
Education	−0.286***	−2.005***	0.574**	0.11	4.726***	5.300***
Sex (Women)	0.098	−3.851***	−0.376	0.31	−0.824	−1.200
Institutionalization	0.440***	−1.881***	−0.828**	0.07	−10.966***	−11.80***

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. The indirect effect is evaluated based on the effect of the predictor on the mediating variable (a), and in turn on the mediating variable on performance in cognitive performance (b). The indirect effect is reported by multiplying the two previous coefficients (a*b). The direct effect presented is the coefficient obtained directly from each predictor on cognitive performance (c).

In the case of age, there was a significant and negative mediation effect of physical reserve, measured with IPAQ, on cognition. The direct effect remained significant and was negative, indicating that overall, age had a negative correlation with cognition, as age increased, MoCA/M@T scores decreased. Parsing the indirect effect, the relation between age and IPAQ

scores was positive, indicating that as age increased, physical activity decreased too (higher IPAQ scores mean lower physical activity). Further, the effect of IPAQ on MoCA and M@T scores was negative, indicating that as physical activity increased, MoCA scores increased. The overall indirect effect was negative, but small, the mediation proportion was less than 10% of the total effect.

Educational level showed a significant positive indirect effect on cognition, and the direct effect remained significant and positive. Indicating that, overall, educational level had positive effects on cognition, either directly, or indirectly *via* physical activity. This indirect effect is constructed with a negative effect of educational level on IPAQ scores, which means that higher educational level is associated with higher physical activity, and a negative effect of IPAQ scores on MoCA/M@T scores, which is interpreted as an association of higher physical activity with higher MoCA/M@T scores. The mediation proportion is similar to that of age, of 11% of the total effect. Overall, higher educational level was associated with higher cognitive scores, either *via* a direct effect and *via* an indirect effect through higher physical activity.

Even though sex did show a direct effect only for MoCA scores, it did not show an indirect effect through physical activity, but there was a statistically significant effect of physical activity on cognition. The effect of IPAQ scores on MoCA scores was negative, indicating that higher physical activity was associated with higher cognitive scores.

Institutionalization showed both significant direct and indirect effects, and the mediation proportion was similar to that of age, which probably indicates that these indirect effects were driven mostly by the age difference among groups.

In summary, physical reserve mediated the effects of age, educational level and institutionalization on cognition. The mediation proportions of physical reserve were lower than those for cognitive reserve. The pattern of results showed that age and institutionalization had negative direct and indirect effects overall, but educational level showed positive direct and indirect effects on cognition. Because of the way the Physical Activity Questionnaire scores are interpreted, where lower scores indicate higher physical activity, the effects of Physical Activity Questionnaire on MoCA and M@T scores were all negative.

Motivational reserve

The summary of the direct, indirect, and total effects of age, educational level, sex, and institutionalization on cognition, mediated by motivational reserve measured with the PIL test, is presented in Table 3. All four sociodemographic variables showed statistically significant total effects, which indicates that they were predictors of cognition measured by MoCA and M@T, except for sex as the independent variable for M@T scores. In neither case of age, educational level, sex, and institutionalization, there were significant indirect effects through PIL scores. The mediation proportion in either case was less than 1% of the total effects. In the mediation analyses with age as the predictor, PIL scores showed statistically significant positive effects on MoCA scores, but the p value was near threshold ($p = 0.012$), which should be interpreted with caution. Also, educational level showed a statistically significant effect on PIL scores, with the same caveat about the p value ($p = 0.028$).

Given the absent indirect effects *via* motivational reserve indexed with PIL scores, we decided to explore separating institutionalized and non-institutionalized older adults, and run the same analyses in both groups only for the motivational reserve. The summary of that analysis is shown in Table 4.

In the case of institutionalized older adults, neither age, educational level, or sex, showed significant indirect effects

TABLE 3 Mediation analysis of the four sociodemographic predictors of cognitive performance (assessed with the MoCA and M@T) contrasted with motivational reserve as a mediating variable (assessed with the PIL).

	Indirect effect				Direct effect	Total effect
	a	b	a*b	Prop.	c	(a*b)+c
MoCA						
Age	0.083	0.027*	0.002	<0.01	−0.213***	−0.211***
Education	2.581*	0.005	0.014	<0.01	2.451***	2.465***
Sex (Women)	−0.420	0.020	−0.009	<0.01	−1.126*	−1.134*
Institutionalization	−1.400	0.016	−0.022	<0.01	−4.978***	−5.000***
M@T						
Age	0.083	0.052**	0.004	<0.01	−0.474***	−0.470***
Education	2.581*	0.005	0.012	<0.01	5.288***	5.300***
Sex (Women)	−0.420	0.037	−0.016	0.01	−1.184	−1.200
Institutionalization	−1.400	0.026	−0.036	<0.01	−11.757***	−11.80***

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. The indirect effect is evaluated based on the effect of the predictor on the mediating variable (a), and in turn on the mediating variable on performance (b). The indirect effect is reported by multiplying the two previous coefficients (a*b). The direct effect presented is the coefficient obtained directly from each predictor on cognitive performance (c).

TABLE 4 Mediation analysis of sociodemographic predictors of cognitive performance (assessed with MoCA and M@T) contrasted with cognitive reserve as a mediating variable (assessed with PIL), separating the effects in the samples of institutionalized and non-institutionalized participants.

Institutionalized	Indirect effect				Direct effect	Total effect
	a	b	a*b	Prop.	c	(a*b)+c
Yes – MoCA						
Age	0.200	0.012	0.002	0.01	−0.136***	−0.134***
Education	1.588	0.002	0.003	<0.01	1.957***	1.960***
Sex (Women)	3.190	0.012	0.038	0.01	−2.615***	−2.577***
No – MoCA						
Age	0.507*	0.027**	0.014	0.44	−0.046	−0.032
Education	4.073*	0.017	0.067	0.06	1.000***	1.067***
Sex (Women)	−4.999	0.024*	−0.120	0.30	−0.281	−0.401
Yes – M@T						
Age	0.200	0.050	0.010	0.04	−0.270***	−0.260***
Education	1.588	0.027	0.043	<0.01	4.389***	4.433***
Sex (Women)	3.190	0.047	0.149	0.04	−4.123**	−3.974**
No – M@T						
Age	0.507*	0.011	0.006	0.60	0.004	0.010
Education	4.073*	−0.000	−0.001	<0.01	1.407***	1.407***
Sex (Women)	−4.999	0.011	−0.055	0.27	−0.146	−0.201

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. The indirect effect is evaluated based on the effect of the predictor on the mediating variable (a), and in turn on the mediating variable on cognitive performance. (b). The indirect effect is reported by multiplying the two previous coefficients (a*b). The direct effect presented is the coefficient obtained directly from each predictor on cognitive performance (c).

through motivational reserve on cognition. The mediation proportions were less than 1%. Interestingly, in the case of non-institutionalized older adults, age showed a statistically significant effect on PIL scores, and PIL scores showed an effect on MoCA scores, but the indirect effect overall did not reach significance ($p = 0.098$).

In the non-institutionalized sample there were no statistically significant indirect effects of either age, educational level or sex on cognition, *via* PIL scores. Though, educational level showed a statistically significant effect on PIL scores ($p = 0.028$), and PIL scores an effect on MoCA scores ($p = 0.011$), with sex as the predictor, but these effects were fairly low, even though they lowered the direct effects of age and sex on cognition, rendering them non-statistically significant.

In summary, motivational reserves measured with the PIL test did not show a mediation effect on cognition over age, educational level, sex, or institutionalization. When looking at the sample of non-institutionalized older adults, PIL scores showed significant effects in relation to age, although the overall indirect effect was not significant.

Discussion

The aim of this study was to examine the influence of cognitive reserve, physical reserve and motivational reserve on the cognitive state of the participants and to analyze the independent variables.

With regards to the cognitive reserve and the age variable, it is worth mentioning that the results found in this study coincide with the results from other authors, like Brichko et al. (2022), who analyzed the role that age has on the level of cognitive reserve and white matter in the elderly. This study concluded that cognitive reserve should be considered as a compensatory variable among older adults. Other studies developed by Ekdahl et al. (2022) and Barulli et al. (2022), in which they used subjects who had been studied through neuropsychological evaluations and structural neuroimaging. The objective was to analyze the associations between these data and the strategic flexibility measures. The results indicated that age had a negative effect on strategic flexibility, but those with higher cognitive reserve had a better cognitive flexibility. These results are consistent with those obtained in this research.

Cuéllar et al. (2022) have carried out a study at the Anahuac University of Mexico in which they have analyzed the role of personality in the cognitive reserve. Various factors have been found to contribute to the formation of cognitive reserves. They found differences in the neuroticism variable between men and women, and less neuroticism, less extraversion and greater conscientiousness at older ages. Thus, they concluded that there are predictors of cognitive reserve in people over the age of 18.

Regarding the sex variable, no significant differences were observed in this study, but it should be noted that, in a recent study, differences were found in favor of men in the education level, languages, occupation and total score, since it was measured

by the Cognitive Reserve Questionnaire. These authors also analyzed the education level of the subjects, suggesting that education could stimulate the search for intellectual enrichment and that, in turn, this would improve the cognitive and functional performance of older people Grasso et al. (2021). On the other hand, a recent study has researched the effect of maintenance and reserve factors measured through neuronal efficiency called phase specificity, in which they concluded that women obtain better results, meaning they have a better and higher brain performance (Argiris et al., 2022).

Another variable studied is the educational level in which in previous studies done by the same authors (Wobbeking et al., 2020) they reached the same conclusion in this present study, stating that the educational level is one of the strongest predictors of cognitive reserve. It should be noted that the Cognitive Reserve Questionnaire scores include questions about the educational level, but the CRS scores do not. This explains why the indirect effect of the educational level through the CRQ scores explained the entire effect and the direct effect disappeared. Therefore, it would be advisable to use CRS to measure different variables, complementary to the educational level.

The results are in line with other studies that support the hypothesis that cognitive reserve influences the delay in the development of cognitive impairment symptoms. In a recent study done by Ihle et al. (2022), with a Portuguese population, it is evident that healthy cognitive functioning is mediated by cognitive reserve (measured with indicators of educational levels and types of professions) and perceived quality of life. This reinforces the important role of cognitive reserve in maintaining healthy aging, especially in its health-related quality of life (HRQoL) dimension.

The second variable studied in this research is the physical reserve. The results show the positive association with cognitive function and the improvement of the motivational reserve, results that coincide with the scientific literature. A study conducted by Mejía et al. (2020) has analyzed the relation between the practice of physical activity and emotional state in adults aged 60 to 70 years, concluding that people who perform low physical activity present a negative emotional state characterized by the presence of symptoms such as anxiety and anger.

Motivational reserve on non-institutionalized older adults, effect of age on PIL, and of PIL on MoCA were significant, but not the full indirect effect. If there were an indirect effect, which we failed to detect due to insufficient statistical power, the effect could be positive, but small, where higher age would be associated with higher purpose in life, and further higher purpose in life would be associated with higher cognitive scores. These results are novel since they relate the cognitive reserve to motivational reserve and specifically to the meaning of life. They extend and converge with many studies that relate the meaning of life with positive neuropsychological aspects such as less anxiety and depression, greater physical, psychological and social well-being, as well as greater life expectancy and optimism (Park et al., 2004; Peterson and Seligman, 2004; Kim et al., 2013; Proyer et al., 2013; Niemiec, 2014; Zilioli et al., 2015; Cohen et al., 2016; Steptoe, 2019; Steptoe and Fancourt, 2019; Trudel-Fitzgerald et al., 2019; Kim et al., 2020; Weziak-Bialowolska et al., 2021; Kim et al., 2022). All these variables can be related by key factors such as positive emotions, which are directly related to these constructs.

In this study, the mediating effects of cognitive reserve, physical reserve and motivational reserve on the cognitive performance of older people were reviewed, based on the predictor variables of age, educational level and institutionalization. The cognitive reserve (assessed with CRQ and CRS) and the physical reserve (assessed with the IPAQ) were found to have important partial mediating effects over age, educational level, and institutionalization over cognitive performance (assessed with MoCA and M@T). The motivational reserve (assessed with the PIL test), had smaller effects but of interest to be reviewed in future studies, especially in the non-institutionalized older population. This study reflects the important relation between cognitive impairment and cognitive reserve, physical reserve and motivational reserve, these being key factors in the process of preventing pathological aging.

We have to recognize two types of limitations in this study. The first is related to the type of methodology used, since it is a cross-sectional study and has a more limited explanatory power than that which would have been made with a longitudinal monitoring of the sample. And the second limitation would be circumscribed to the instruments used, especially regarding the measurement of cognitive reserve. This is a matter of controversy in the literature, given the difference that exists between the measurements scales of the constructs. Although we must point out that the one used meets the two basic criteria required in most works (Kartschmit et al., 2019): include the relevant key aspects (education-training, profession-education, physical activities-leisure) and being among the six instruments with better psychometric properties.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval were not required for the study on human participants in accordance with the local legislation and institutional requirements. The patients/participants provided their written informed consent to participate in this study.

Author contributions

AC, MWS, and BB-L: conceptualization and resources. MM-R and JU-L: methodology and data curation. MWS: validation. MM-R: formal analysis. MWS, BB-L, and AC: investigation. EC-R:

writing—original draft preparation. EC-R and MM-R: writing—review and editing. MWS, JU-L, AC, and BB-L: visualization and project administration. AC, MM-R, and MWS: supervision. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The reviewer JL declared a past collaboration with the authors AS and BB-L to the handling editor.

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References

Adam, S., Bonsang, E., Grotz, C., and Perelman, S. (2013). Occupational activity and cognitive reserve: implications in terms of prevention of cognitive aging and Alzheimer's disease. *Clin. Interv. Aging* 8, 377–390. doi: 10.2147/CIA.S39921

Aldas, C., Chara, N., Guerrero, P., and Flores, R. (2021). Actividad física en el adulto mayor [physical activity in the elderly]. *Revista científica ciencias de la salud* 7, 64–77.

Arenaza-Urquijo, E. M., and Vemuri, P. (2018). Resistance vs resilience to Alzheimer disease: clarifying terminology for preclinical studies. *Neurology* 90, 695–703. doi: 10.1212/WNL.0000000000005303

Argiris, G., Stern, Y., and Habeck, C. (2022). Neural similarity across task load relates to cognitive reserve and brain maintenance measures on the letter Sternberg task: a longitudinal study. *Research Square*. doi: 10.21203/rs.3.rs-1677138/v1

Barba, P. (2021). La reserva cognitiva como prevención en el deterioro de las funciones neurocognitivas en la vejez [Cognitive reserve as a prevention for deterioration of neurocognitive functioning in older people]. *revistahorizontes* 5, 1074–1083. doi: 10.33996/revistahorizontes.v5i20.258

Bartrés-Faz, D., et al. (2018). Meaning in life: resilience beyond reserve. *Alzheimers Res. Ther.* 10:47. doi: 10.1186/s13195-018-0381-z

Barulli, D., Habeck, C., and Stern, Y. (2022). Assessing strategic flexibility: strategy-shifting as a mechanism of cognitive reserve. *Psychol. Aging*. doi: 10.31234/osf.io/fushm

Barulli, D., and Stern, Y. (2013). Efficiency, capacity, compensation, maintenance, plasticity: emerging concepts in cognitive reserve. *Trends Cogn. Sci.* 17, 502–509. doi: 10.1016/j.tics.2013.08.012

Brichko, R., Soldan, A., Zhu, Y., Wang, M., Faria, A., Alberto, M., et al. (2022). Age-dependent association between cognitive reserve proxy and longitudinal white matter microstructure in older adults. *Front. Psychol.* 13:859826. doi: 10.3389/fpsyg.2022.859826

Chapko, D. (2018). Life-course determinants of cognitive reserve (CR) in cognitive aging and dementia – a systematic literature review. *Aging Ment. Health* 22, 921–932. doi: 10.1080/13607863.2017.1348471

Cheng, S. T. (2016). Cognitive reserve and the prevention of dementia: the role of physical and cognitive activities. *Curr. Psychiatry Rep.* 18:85. doi: 10.1007/s11920-016-0721-2

Cohen, R., Bavishi, C., and Rozanski, A. (2016). Purpose in life and its relationship to all-cause mortality and cardiovascular events: a meta-analysis. *Psychosom. Med.* 78, 122–133. doi: 10.1097/PSY.0000000000000274

Craig, C. L., et al. (2003). International physical activity questionnaire: 12-country reliability and validity. *Med. Sci. Sports Exerc.* 35, 1381–1395. doi: 10.1249/01.MSS.0000078924.61453.FB

Crumbaugh, J. C., and Maholick, L. T. (1964). An experimental study in existentialism: the psychometric approach to Frankl's concept of noogenic neurosis. *J. Clin. Psychol.* 20, 200–207. doi: 10.1002/1097-4679(196404)20:2<200::AID-JCLP2270200203>3.0.CO;2-U

Crumbaugh, J. C., and Maholick, L. T. (1969). *Manual of instructions for the purpose En life test*. Saratoga: Viktor Frankl. Institute for Logotherapy.

Cuéllar, M., Villegas, A., Dager, I., Molina, Z., and Toledo, A. (2022). *Factores de personalidad asociados a la Reserva cognitiva: Un estudio longitudinal en línea [personality factors associated with cognitive reserve: An online longitudinal study]*. Universidad Anáhuac México, Facultad de Psicología, Mexico.

Deci, E. L., and Ryan, R. M. (1985). "Conceptualizations of intrinsic motivation and self-determination" in *Intrinsic motivation and self-determination in human behavior* (Boston, MA: Springer), 11–40.

Ekdahl, N., Godbolt, A., Nygren Deboussard, C., Lannsjö, M., Stålnacke, B., Stenberg, M., et al. (2022). Cognitive reserve, early cognitive screening, and relationship to long-term outcome after severe traumatic brain injury. *J. Clin. Med.* 11:2046. doi: 10.3390/jcm11072046

Grasso, L., Aceiro, M., Aschiero, M., González, A., Iglesia, F., and López, M. (2021). Cognitive reserve in healthy older adults. *MOJ Gerontology & Geriatrics* 6, 46–50.

Guerrini, S., Hunter, E., Papagno, C., and MacPherson, S. (2022). Cognitive reserve and emotion recognition in the context of normal aging. *Aging Neuropsychol. Cognit.* 1-19, 1–19. doi: 10.1080/13825585.2022.2079603

Ihle, A., Gouveia, É. R., Gouveia, B. R., Marques, A., Marconcin, P., de Maio Nascimento, M., et al. (2022). Cognitive functioning mediates the Association of Cognitive Reserve with health-related quality of life. *Sustainability* 14:826. doi: 10.3390/su14020826

Jiménez, E., Fernández, Z., Broche, Y., and Abreu, R. (2021). Instrumentos para la evaluación neurocognitiva del adulto mayor. Una revisión sistemática [Instruments for neurocognitive assessment in older adults. A systematic review]. *Neurama Revista de Psicogerontología* 8, 53–62.

Kartschmit, N., et al. (2019). Measuring cognitive reserve (CR) – a systematic review of measurement properties of CR questionnaires for the adult population. *PLoS One* 14:e0219851. doi: 10.1371/journal.pone.0219851

Kim, E. S., Chen, Y., Nakamura, J. S., Ryff, C. D., and VanderWeele, T. J. (2022). Sense of purpose in life and subsequent physical, Behavioral, and psychosocial health: an outcome-wide approach. *Am. J. Health Promot.* 36, 137–147. doi: 10.1177/08901171211038545

Kim, E. S., Shiba, K., Boehm, J. K., and Kubzansky, L. D. (2020). Sense of purpose in life and five health behaviors in older adults. *Prev. Med.* 139:106172. doi: 10.1016/j.ypmed.2020.106172

Kim, E. S., Sun, J. K., and Park, N. (2013). Peterson, C. purpose in life and reduced incidence of stroke in older adults: "the health and retirement study.". *J. Psychosom. Res.* 74, 427–432. doi: 10.1016/j.jpsychores.2013.01.013

Lavrencic, L. M., Churches, O. F., and Keage, H. A. D. (2018). Cognitive reserve is not associated with improved performance in all cognitive domains. *Appl. Neuropsychol. Adult* 25, 473–485. doi: 10.1080/23279095.2017.1329146

León, I., García, J., and Roldán, L. (2015). Escala de Reserva Cognitiva y Envejecimiento [scale of cognitive reserve and aging]. *Anales de Psicología* 32, 218–223. doi: 10.6018/analesps.32.1.182331

León, I., García, J., and Roldán, L. (2017). Escala de Reserva Cognitiva: Ajuste del Modelo teórico y baremación [cognitive reserve scale: fit of the theoretical model and norms]. *Rev. Neurol.* 64, 7–16. doi: 10.33588/rn.6401.2016295

Lozano, M., et al. (2019). Validation of Spanish-language version of the Montreal cognitive assessment test in adults older than 60 years. *Neurologia (Engl Ed)* 34, 376–385. doi: 10.1016/j.nrl.2017.01.013

Martínez, R., García-Alandete, J., Sellés, P., Bernabé, G., and Soucase, B. (2012). Análisis factorial confirmatorio de los principales modelos propuestos Para el purpose in life test en una muestra de universitarios españoles [confirmatory factorial analysis of the main models proposed for the purpose in life test in a sample of Spanish university students]. *Acta Colombiana de Psicología* 15, 67–76. doi: 10.1037/t01175-000

Martínez, N., Santaella, E., and Rodríguez, A. (2021). Benefits of physical activity for the promotion of active aging in elderly. *Bibliographic review. Retos: nuevas tendencias en educación física, deporte y recreación* 39, 829–834.

Mejía, U., Guerrero, A., Lorenzo, I., and Sosa, A. (2020). Physical activity and its association with emotional state in the elderly with obesity. *Atención Familiar* 28, 10–15. doi: 10.22201/fm.14058871p.2021.1.77654

Nasreddine, Z. S., Phillips, N. A., Bedirian, V., Charbonneau, S., Whitehead, V., Collin, I., et al. (2005). The Montreal cognitive assessment, MoCA: a brief screening tool for mild cognitive impairment. *J. Am. Geriatr. Soc.* 53, 695–699. doi: 10.1111/j.1532-5415.2005.53221.x

Niemiec, R. M. (2014). *Mindfulness and character strengths: A practical guide to flourishing*. Germany: Hogrefe.

Nithianantharajah, J., and Hannan, A. J. (2009). The neurobiology of brain and cognitive reserve: mental and physical activity as modulators of brain disorders. *Prog. Neurobiol.* 89, 369–382. doi: 10.1016/j.pneurobio.2009.10.001

Ochoa-Vázquez, J., Cruz-Ortiz, M., Pérez-Rodríguez, M. D. C., and Cuevas-Guerrero, C. E. (2019). Aging: a look at the demographic transition and its implications for health care. *Revista de Enfermería del Instituto Mexicano del Seguro Social* 26, 273–280.

Opdebeeck, C., Martyr, A., and Clare, L. (2016). Cognitive reserve and cognitive function in healthy older people: a meta-analysis. *Aging Neuropsychol. Cognit.* 23, 40–60. doi: 10.1080/13825585.2015.1041450

Ozer, S., et al. (2016). The validity of the memory alteration test and the test your memory test for community-based identification of amnestic mild cognitive impairment. *Alzheimers Dement.* 12, 987–995. doi: 10.1016/j.jalz.2016.03.014

Park, N., Peterson, C., and Seligman, M. E. P. (2004). Strengths of character and well–being. *J. Soc. Clin. Psychol.* 23, 603–619. doi: 10.1521/jscp.23.5.603.50748

Peterson, C., and Seligman, M. E. P. (2004). *Character strengths and virtues. A handbook and classification*. United States: Oxford University Press and American Psychological Association.

Petri, H. L., and Govern, J. M. (2021). *Motivation: Theory, research, and application*. Boston: Cengage Learning.

Pettigrew, C., and Soldan, A. (2019). Defining cognitive reserve and implications for cognitive aging. *Curr. Neurol. Neurosci. Rep.* 19:1. doi: 10.1007/s11910-019-0917-z

Pinquart, M. (2002). Creating and maintaining purpose in life in old age: a meta-analysis. *Ageing Int.* 27, 90–114. doi: 10.1007/s12126-002-1004-2

Proyer, R. T., Gander, F., Wellenzohn, S., and Ruch, W. (2013). What good are character strengths beyond subjective well-being? The contribution of the good character on self-reported health-oriented behavior, physical fitness, and the subjective health status. *J. Posit. Psychol.* 8, 222–232. doi: 10.1080/17439760.2013.777767

Rami, L. (2009). Validez discriminativa y asociación del test minimental (MMSE) y del test de alteración de memoria (T@M) con una batería neuropsicológica en pacientes con deterioro cognitivo leve amnésico y enfermedad de Alzheimer [discriminatory validity and association of the mini-mental test (MMSE) and the memory alteration test (M@T) with a neuropsychological battery in patients with amnestic mild cognitive impairment and Alzheimer's disease]. *Rev. Neurol.* 49, 169–174. doi: 10.33588/rn.4904.2008623

Rami, L., Molinuevo, J., Sanchez-Valle, R., Bosch, B., and Villar, A. (2007). Screening for amnestic mild cognitive impairment and early Alzheimer's disease with M@T (memory alteration test) in the primary care population. *Int. J. Geriatr. Psychiatry* 22, 294–304. doi: 10.1002/gps.1672

Rami, L., Valls-Pedret, C., Bartrés-Faz, D., Caprile, C., Solé-Padullés, C., Castellví, M., et al. (2011). Cuestionario de Reserva cognitiva. Valores obtenidos en población anciana sana y con enfermedad de Alzheimer [cognitive reserve questionnaire. Values obtained in healthy elderly population and with Alzheimer's disease]. *Rev. Neurol.* 52, 195–201. doi: 10.33588/rn.5204.2010478

Reich, J. W., Zautra, A. J., and Hall, J. S. (2004). *Handbook of adult resilience*. New York: Guilford Press, *2010*.

Rodríguez, A., García, J., and Luje, D. (2020). Los beneficios de la actividad física en la calidad de Vida de los adultos mayores [the benefits of physical activity on the quality of life of older adults]. *EmásF: Revista digital de educación física* 63, 22–35.

Sitges, E. (2019). Prólogo. En A. Sánchez-Cabaco and N. Barahona Esteban (Dirs.). *Estimulación integral del envejecimiento con sentido: Combinando procesos cognitivos y emocionales [comprehensive stimulation of aging with meaning: Combining cognitive and emotional processes]* (pp.7–8). Sindéresis: Universidad Miguel Hernández de Elche.

Sousa, M. (2015). Initial phase of adaptation of memory alteration test (M@T) in a Portuguese simple. *Arch. Gerontol. Geriatr.* 61, 103–108. doi: 10.1016/j.archger.2015.03.008

Steptoe, A. (2019). Happiness and health. *Annu. Rev. Public Health* 40, 339–359. doi: 10.1146/annurev-publhealth-040218-044150

Steptoe, A., and Fancourt, D. (2019). Leading a meaningful life at older ages and its relationship with social engagement, prosperity, health, biology, and time use. *Proc. Natl. Acad. Sci. U. S. A.* 116, 1207–1212. doi: 10.1073/pnas.1814723116

Stern, Y. (2002). What is cognitive reserve? Theory and research application of the reserve concept. *JINS* 8, 448–460. doi: 10.1017/S1355617702813248

Stern, Y., Habeck, C., Moeller, J., Scarmeas, N., Anderson, K. E., Hilton, H. J., et al (2005). Brain networks associated with cogni- tive reserve in healthy young and old adults. *Cerebral Cortex,* 15, 394–402. doi: 10.1093/cercor/bhh142

Stern, Y. (2009). Cognitive reserve. *Neuropsychology* 47, 2015–2028. doi: 10.1016/j.neuropsychologia.2009.03.004

Stern, Y., and Barulli, D. (2019). Cognitive reserve. *Geriatric Neurology* 167, 181–190. doi: 10.1016/b978-0-12-804766-8.00011-x

Trudel-Fitzgerald, C., James, P., Kim, E. S., Zevon, E. S., Grodstein, F., and Kubzansky, L. D. (2019). Prospective associations of happiness and optimism with lifestyle over up to two decades. *Prev. Med.* 126:105754. doi: 10.1016/j.ypmed.2019.105754

World Health Organization. (2020). Physical activity."Recovered in 5 octuber 2022 in https://www.who.int/news-room/fact-sheets/detail/physical-activity".

World Health Organization. (2021). Aging and health. "Recovered in 1 october 2022 in https://www.who.int/es/news-room/fact-sheets/detail/ageing-and-health".

Weziak-Bialowolska, D., Bialowolski, P., VanderWeele, T. J., and McNeely, E. (2021). Character strengths involving an orientation to promote good can help your health and well-being. Evidence from two longitudinal studies. *Am. J. Health Promot.* 35, 388–398. doi: 10.1177/0890117120964083

Wobbeking, M., Bonete, B., Cabaco, A. S., Urchaga, J. D., and Afonso, M. (2020). Relationship between cognitive reserve and cognitive impairment in autonomous and institutionalized older adults. *Int. J. Environ. Res. Public Health* 17:5777. doi: 10.3390/ijerph17165777

Wobbeking, M., Sánchez, A., Bonete, B., Urchaga, J. D., Loureiro, M. J., and Mejía, M. (2021). Psychical activity and life satisfaction: an empirical study in a population of senior citizens. *Front. Psychol.* 12:636914. doi: 10.3389/fpsyg.2021.636914

World Health Organization. (2012). International physical activity questionnaire IPAQ (versión 2.0.). Available at: https://www.who.int/ncds/surveillance/steps/instrument/es/

Zilioli, S., Slatcher, R., Ong, A. D., and Gruenewald, T. L. (2015). Purpose in life predicts allostatic load ten years later. *J. Psychosom. Res.* 79, 451–457. doi: 10.1016/j.jpsychores.2015.09.013

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 30 January 2023
DOI 10.3389/fpsyg.2023.994128

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OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Movement Science and Sport Psychology, a section of the journal Frontiers in Psychology

RECEIVED 14 July 2022
ACCEPTED 04 January 2023
PUBLISHED 30 January 2023

CITATION
Wada Y, Bizen Y and Inaba M (2023) Exploring the effects of COVID-19 on motorcycle riding patterns and its importance.
Front. Psychol. 14:994128.
doi: 10.3389/fpsyg.2023.994128

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Exploring the effects of COVID-19 on motorcycle riding patterns and its importance

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A motorcycle refers to a two-wheeled, personal mobility vehicle used for daily transportation and leisure activities. Leisure enables social interaction, and motorcycle riding could be an activity that facilitates social interactions and distancing. Therefore, grasping the importance of riding motorcycles during the pandemic—which involved social distancing and limited leisure activities—can be valuable. However, researchers have yet to examine its potential importance during the pandemic. Therefore, this study aimed to determine the importance of personal space and time spent with others in the context of motorcycle riding during the COVID-19 pandemic. We specifically explored the effects of COVID-19 on riding patterns and importance of riding motorcycle by examining whether these factors differed regarding changes in the frequency of motorcycle riding before and during the pandemic in daily and leisure-oriented transportation. Data were collected from 1,800 motorcycle users in Japan using a web-based survey conducted in November 2021. Respondents replied to questions concerning the importance of personal space and time spent with others attributed to motorcycle riding before and during the pandemic. Following the survey, we conducted a two-way repeated measures analysis of variance (two-factor ANOVA) and performed a simple main effect analysis using the SPSS syntax editor in case of interactions. The valid samples for motorcyclists with leisure motive (leisure-oriented users) and daily transportation motive (daily users) numbered n = 890 and n = 870, respectively (total n = 1,760, 95.5%). Each valid sample was divided into three groups based on the differences in motorcycle riding frequency before and during the pandemic: unchanged, increased frequency, and decreased frequency. The two-factor ANOVA results showed significant differences in the interaction effects for leisure-oriented and daily users regarding personal space and time spent with others. The mean value of the "increased frequency" group during the pandemic indicated significantly higher importance of personal space and time spent with others than the other groups. Motorcycle riding could enable daily transportation and leisure-oriented users to practice social distancing while simultaneously spending time with companions and alleviating loneliness and isolation during the pandemic.

KEYWORDS

personal space, social distancing space, leisure activities, motorcycle riding, COVID-19

Introduction

The pandemic has globally restricted people from daily transportation and leisure activities for the past several years. COVID-19 has not allowed individuals to casually gather or spend time with others. Moreover, utilizing public transportation is recognized as having a higher risk of infection due to being in contact with many people, and people consequently preferred private vehicles over public transportation (Huang et al., 2020; Scorrano and Danielis, 2021). During the COVID-19 pandemic, people have been forced to stay at home instead of having face-to-face interactions; moreover, online communications, which maintain individual personal space, have become the mainstream way of connecting and spending time with others. Such social interactions have increased the sedentary lifestyles of people at home (Sivan, 2020). Although leisure time and activities offer good communication functions for promoting connectedness with others, the COVID-19 pandemic has made it difficult to have social interactions during leisure time (Norbury, 2021).

Motorcycles are widely used in daily life, especially in Asian countries, as a convenient means of transportation. In addition to daily transportation, many people enjoy riding motorcycles as a leisure activity. During COVID-19, the need to maintain social distancing to prevent infection has greatly restricted our daily lives. Under such circumstances, motorcycles are a one-person vehicle that have the advantage of allowing people to participate in activities while maintaining sufficient distance from others. Studies indicated that people changed their choice of daily transportation from public to private mode (Scorrano and Danielis, 2021), and outdoor leisure activities such as hiking, running, and cycling, which are enjoyable alone while ensuring personal space, became popular (van Leeuwen et al., 2020) as a result of the pandemic. The media reported that the COVID-19 pandemic led to a surging demand for motorcycle riding for daily transportation to practice social distancing (Kyodo News, 2022); this may also indicate that people chose motorcycles to ensure personal space and keep their distance from others. Additionally, according to the Japan Automobile Manufacturers Association, Inc [JAMA] (2022), the demand for motorcycles has increased because of the COVID-19 pandemic, and motorcycle riding may help avoid infection and the "Three Cs" (closed spaces, crowded places, and close-contact settings).

The COVID-19 pandemic has made people feel isolated and lonely (Sivan, 2020). Therefore, finding ways to practice social distancing while connecting with others could be essential during and after COVID-19 for new lifestyles and leisure activities or time. Has the impact of COVID-19 caused any change in motorcycle riding patterns and riders' importance to motorcycle riding as the demand for motorcycles increases? It is assumed that the importance of riding motorcycles for riders enhanced for maintaining social distancing while spending time with others during the COVID-19 pandemic. However, researchers still need to examine the question. Thus, it is necessary to determine whether the riding patterns and riders' importance to motorcycle riding have changed due to the COVID-19 pandemic.

Literature review

Maintaining personal space

We consider the distance between ourselves and others daily, either consciously or unconsciously. Moreover, everyone has a personal space—a distance that is comfortable for the individual. The concept of personal space is often used in social psychology and is defined as the emotional realm around an individual's body. Personal space consists of physical and metaphorical aspects (Sommer, 1959). The meaning of personal space varies depending on the internal state, culture, and context. Therefore, personal space in leisure activities can also be considered a space detached from daily life (O'Brien et al., 2017). Many researchers have examined the relationship between personal space and human behavior.

For example, Gérin-Lajoie et al. (2008) examined changes in the personal space maintained around oneself during locomotion. They measured personal space in 10 adults while avoiding obstacles stationary in their path and found no relationship between walking speed and personal space. Motorcycles, the subject of this study, usually travel at speeds of 40 km/h or more, which is faster than walking. Therefore, examining personal space when riding a motorcycle will be necessary.

Welsch et al. (2019) examined the relationship between interpersonal distance and discomfort. People feel uncomfortable when their personal space is invaded. The researchers presented 15 different interpersonal distances ranging from 40 cm to 250 cm, and subjects rated their discomfort for each distance. The results revealed a correlation between personal space and discomfort. Regarding the relationship between gender and personal space, women get closer to other women when interacting (Hartnett et al., 1970). Moreover, Hecht et al. (2019) conducted experiments to measure personal space and found that a person's personal space is circular with a radius of 1 m and that male-male pairs maintain more distance than female-female pairs or mixed-gender pairs. The Parietal-Frontal network of the human brain works to maintain interpersonal relationships and a specific "Comfort Zone" or personal space. Using fMRI experiments from a brain science perspective, Holt et al. (2014) found that the strength of the response between the dorsal intraparietal sulcus (DIPS) and ventral premotor cortex (PMv) is correlated with personal space and affects the preferred level of social activity.

The environment is a factor which determines human behavior, and research on how people utilize their environment to create social interactions has long been conducted with a focus on human behavior (Altman and Vinsel, 1977). In particular, as technologies such as virtual reality (VR) have evolved in recent years and the use of virtual environments has increased, there is a possibility that interpersonal distance in the real world has also changed. Kraut et al. (1998) found that increased Internet use causes a decrease in communication with family members and a smaller social circle, which is associated with increased depression and loneliness. While riding a motorcycle, one is basically in a state of maintaining distance from others. As social interaction and personal space change over time, it would be an interesting theme to examine the relationship between motorcycle riding and distance from others. Since the goal of this study is to examine the importance of social interactions with others in the context of motorcycle riding in the COVID-19

pandemic, we reviewed the following studies on social interaction with others.

Social interactions regarding riding a motorcycle

Time spent with others and social interactions are crucial benefits of leisure (Sivan, 2020). The central concept of leisure refers to the free time in which an individual is neither working nor occupied by miscellaneous duties or obligations (Zijlstra and Sonnentag, 2006), and it is recognized as a pivotal time that includes activities that stimulate self-development and promote stress release (Liu et al., 2022). Furthermore, close relationships and leisure time with others promote subjective wellbeing (Newman et al., 2014; Hudson et al., 2020). The time spent with other people is critical as it could be related to individuals' overall wellbeing.

Motorcycle riding as an outdoor leisure activity increases happiness in one's life regardless of riding alone or in tandem (Kruger and Venter, 2020). There are two types of leisure—casual and serious. While casual leisure refers to relatively short-duration enjoyable activities that require neither special skills nor training, serious leisure entails pursuing special skills, knowledge, or experience, even as a hobby or at an amateur level (Stebbins, 1997). Motorcyclists have characteristics that include serious leisure, such as a strong sense of community and comradeship with other motorcyclists (Frash and Blose, 2019). Moreover, motorcyclists tend to have a "sense of belonging" or "sense of camaraderie" with other motorcyclists even when meeting for the first time or passing by each other on the road (Stokburger-Sauer, 2010; Walker, 2010; Frash and Blose, 2019). Therefore, riding a motorcycle might produce valuable opportunities to interact during the pandemic.

Scorrano and Danielis (2021) found that people had negative perceptions of riding public transportation, which led to a choice shift in choice from public to private vehicles during the pandemic; however, across motorized mobilities, such as a motorcycle and car, have low substitutability. Thus, motorcyclists' frequency and importance of motorcycle riding may have changed before and during COVID-19. Understanding the riding frequency and importance of motorcyclists maintaining their personal space while spending time with others before and during the pandemic may lead to examining the utility of motorcycle riding in alleviating loneliness and isolation. Therefore, this study aimed to determine the importance of personal space and time spent with others in motorcycle riding during the COVID-19 pandemic. We specifically compared the importance of motorcycle riding based on changes in the frequency of motorcycle riding before and during the pandemic in both daily and leisure-oriented transportation.

People worldwide have been isolated and feel lonely due to the unexpected COVID-19 pandemic. We focused on the increased demand for outdoor leisure activities and purchasing motorcycles while people have been forced to change their lifestyles due to restrictions on daily transportation and leisure activities. Prior studies indicate that motorcycle is a convenient vehicle (Yamamoto, 2009; Crowther, 2011; Hanafi et al., 2019) and has the potential to enhance the quality of life (Newman et al., 2014; Hudson et al., 2020). Although a motorcycle is a personal vehicle with applications ranging from daily transportation to leisure activities, the importance of motorcycle riding has not been examined. Therefore, the present study might be valuable in demonstrating the usefulness of motorcycle riding for practicing social distancing and interaction in our lives. In particular, clarifying the growing importance of motorcycle riding in the post-pandemic lifestyle, outdoor leisure, and motorcycling-related academic studies could provide clues to new findings.

Practically, it remains unclear whether the demand for motorcycles during the pandemic was increased due to consumers' need to maintain their personal space and leisure activities. Exploring whether COVID-19 affected motorcycle riding patterns and its importance and examining whether motorcycle riding contributes to maintaining personal space and social interaction would have implications for the wellbeing of people through motorcycle riding in their new lifestyle post-COVID-19.

Materials and methods

We conducted a web-based survey in Japan using an Internet research company from November 18 to November 25, 2021. Respondents were registrants of the aforementioned internet research company, and they could participate the survey once. Data were collected from 1,800 Japanese motorcycle users aged 16 (18 for 401cc and above) to 69 who have purchased from Japanese motorcycle manufacturers (Honda, Kawasaki, Suzuki, and Yamaha). According to a survey (Japan Automobile Manufacturers Association, Inc [JAMA], 2022), motorcycle use can be categorized into two types: daily use (e.g., shopping and commuting to work) and leisure use (e.g., traveling on holidays). In our survey, we first asked about participants' most recent motorcycle purchase experience, and those who responded with "yes" were asked about the manufacturers and purpose of using a motorcycle. The sample size was set and data were collected to avoid motorcycle manufacturers and displacement biases. As we expected that collecting data of participants with motorcycles under 250cc is easier compared to those with motorcycles over 251cc in Japan, we controlled to collect the same ratio of samples for both motorcycle displacements—under 250cc and over 251cc. Samples were asked about the purpose of purchasing the motorcycle using a multiple choice question. Valid samples were those who currently use motorcycles for daily transportation motives (daily users) and motorcyclists with leisure motives (leisure-oriented users).

Respondents answered questions regarding the importance of time spent with others and personal space due to motorcycle riding before and during the pandemic through Visual Analog Scales (VAS). The VAS is a psychometric rating scale similar to the Likert and Semantic differential scales and is recognized as a reliable scale for measuring pain within medical research studies (Bijur et al., 2001; Bielewicz et al., 2022). Respondents slid the point on a line rating from 0 to 100% in the VAS instead of choosing numbers in Likert scales. The VAS may take longer to answer than the Likert scale. However, Funke and Reips (2012) revealed no adverse effects of using the VAS, such as higher dropout, more non-response, or higher response times, on a Web-based survey. Moreover, the VAS can measure respondents' perceived feelings objectively and is suitable for comparing respondents (Brazier et al., 2003). Thus, more precise data for measuring respondents' feelings and recognition could be obtained by utilizing the VAS. Therefore, we used the VAS in this study and asked—regardless of the purpose for owning a motorcycle, daily transportation motives, or leisure-oriented purpose—whether

motorcycle owners were able to maintain social distance and spend their time with others by riding a motorcycle during COVID-19. We specifically examined whether these factors differed based on changes in the frequency of motorcycle riding before and during the pandemic. Question items were, "How important is the personal space (individual space) provided by riding a motorcycle to you?" and "How important is the time you spend with your family and friends that you get from riding a motorcycle?" Respondents answered questions using the VAS, from (0%) "not important at all" to (100%) "very important" before and during the pandemic.

Following the survey, we conducted a two-way repeated measures analysis of variance (two-factor ANOVA) to compare the means of importance of riding a motorcycle regarding two factors: pandemic (i.e., before and during COVID-19) and motorcycle riding frequency. We examined a simple main effect analysis using the SPSS syntax editor in case of interactions *via* SPSS Version 27 (IBM Corp, 2020). Two-factor ANOVA includes two independent variables. Meanwhile, two-way repeated measures ANOVA is conducted when the independent variable includes comparisons of means between the same groups over time (e.g., pre and post). A simple main effect analysis will be required if interaction effects are present.

Results

Demographics of respondents

Approximately 90% of respondents were male, and their mean age was around 50 years of age. A previous research study mentioned that most motorcycling tourists were males over 40 years of age (Carter, 2017), and the Japan Automobile Manufacturers Association, Inc [JAMA] (2022) mentioned the mean age of the respondents as 54.2 years old in the survey. Therefore, the participants in this survey are representative of Japanese motorcyclists. About 60% of respondents were married with children. Concerning their occupation, about half of them were businesspeople, of which 5% were executives. The monthly discretionary amount was about 70,000 yen (US$500; 1US$ = 140 yen). Considering the monthly discretionary amount of the Japan Professional Football League stadium attendees is 36,100 yen (US$257.85; 1US$ = 140 yen) (Japan Professional Football League, 2020), the monthly discretionary amount of motorcyclists could be high.

The valid samples for motorcyclists with daily transportation motives (daily users) numbered $n = 870$ and leisure motives (leisure-oriented users) numbered $n = 890$, respectively (total $n = 1{,}760$, 95.5%). Valid samples were divided into three groups based on the differences in motorcycle riding frequency before and during the pandemic: (1) unchanged (daily users, $n = 629$; leisure-oriented users, $n = 570$), (2) increased frequency (daily users, $n = 101$; leisure-oriented users, $n = 116$), and (3) decreased frequency (daily users, $n = 140$; leisure-oriented users, $n = 204$).

As mentioned previously, this study included both leisure-oriented and daily motorcycle users and showed that approximately 90% of the respondents were male (daily users = 85.5%; leisure-oriented users = 93.4%), and their mean age was around 50 years. According to a report by Japan Automobile Manufacturers Association, Inc [JAMA] (2022), approximately 80% of motorcyclists in Japan ride solo, while only 20% ride in a group. Furthermore, the report revealed that more men than women ride solo (Japan Automobile Manufacturers Association, Inc [JAMA], 2022). Considering that about 90% of the participants in this survey were men, this result suggests that the majority of participants were riding solo. Regarding the engine displacements of motorcycles owned by the respondents, daily users owned smaller displacement engine motorcycles compared to leisure-oriented users; moreover, 40.5% of daily users owned under-50cc motorcycles, while half of the leisure-oriented users owned motorcycles over 401cc (see **Table 1**).

Results of two-factor ANOVA

Tables 2, **3** and **Figures 1–4** show the results of the two-factor ANOVA and multiple comparisons for the importance of personal space and time spent with others for daily-oriented and leisure-oriented motorcycle users.

In **Tables 2**, **3** and **Figures 1–4**, riding frequency is classified as (a) unchanged, (b) increased, and (c) decreased group. The mean score for the importance of personal space and time spent with others is divided between (d) before and (e) during COVID-19. The vertical axis of **Figures 1–4** indicates the means scores for the importance of personal space and time spent with others, and the horizontal axis represents (d) before and (e) during COVID-19 as the timeline.

Daily users

Table 2 and **Figures 1**, **2** show the results of the two-factor ANOVA and multiple comparisons for the daily users. The two-factor ANOVA results showed significant differences in the interaction effects for daily users in terms of both importance of personal space [$F(2{,}867) = 28.85$, $p < 0.001$] and time spent with others [$F(2{,}867) = 18.43$, $p < 0.001$].

The results of the simple main effect analysis for the importance of personal space showed significant differences in the motorcycle riding frequency condition [$F(2{,}867) = 13.55$, $p < 0.001$] and the pandemic condition [$F(1{,}867) = 29.78$, $p < 0.001$]. Multiple comparisons regarding riding frequency showed that the mean score of the increased group ($M = 64.70$, SD = 22.01) was significantly higher than that of the unchanged group ($M = 56.22$, SD = 23.91) before COVID-19, and that the mean score of the increased group ($M = 74.36$, SD = 19.71) was significantly higher than that of the unchanged ($M = 57.27$, SD = 23.69) and decreased groups ($M = 56.68$, SD = 25.95) during COVID-19.

Multiple comparisons between before and during COVID-19 indicated that the increased group's mean score during COVID-19 ($M = 74.36$, SD = 19.71) was significantly higher than that before COVID-19 ($M = 64.70$, SD = 22.01) at a 0.001 significance level. The unchanged group indicated that the mean score during COVID-19 ($M = 57.27$, SD = 23.69) was significantly higher than that before COVID-19 ($M = 56.11$, SD = 23.91) at a 0.01 significance level. However, the difference in mean scores between these two groups might be small due to the minimal effect size ($\eta 2 = 0.007$) (Cohen, 1988).

Regarding the importance of the simple main effect analysis for time spent with others, the results indicated significant differences in the motorcycle riding frequency condition [$F(2{,}867) = 16.23$, $p < 0.001$] and the pandemic condition [$F(1{,}867) = 10.15$, $p < 0.001$]. The increased group's mean score before COVID-19 ($M = 57.57$,

TABLE 1 Gender and age of respondents and their motorcycles' engine displacement.

	Daily users							Leisure-oriented users						
	Group	*n*	Male			Female		*n*	Male			Female		
Gender	(1) Unchanged	629	63.0%			9.3%		570	59.8%			4.3%		
	(2) Increased	101	9.8%			1.9%		116	11.8%			1.2%		
	(3) Decreased	140	12.7%			3.3%		204	21.8%			1.1%		
	Total	870	85.5%			14.5%		890	93.4%			6.6%		
		n	Mean			SD		*n*	Mean			SD		
Age	(1) Unchanged	629	51.51			9.85		570	51.95			9.30		
	(2) Increased	101	50.67			10.62		116	49.67			9.60		
	(3) Decreased	140	51.16			10.62		204	52.23			8.60		
	Total	870	51.36			10.06		890	51.71			9.21		
		n	Under 50cc	51–125cc	126–250cc	251–400cc	Over 401cc	Un-known	*n*	Under 50cc	51–125cc	126–250cc	251–400cc	Over 401cc	Un-known
Engine displacements	(1) Unchanged	629	30.3%	22.6%	8.7%	5.3%	4.8%	0.4%	570	0.7%	5.2%	11.5%	12.5%	34.2%	0.1%
	(2) Increased	101	4.4%	3.4%	1.7%	1.7%	0.3%	0.0%	116	0.1%	1.1%	3.7%	2.8%	5.3%	0.0%
	(3) Decreased	140	5.7%	5.2%	1.8%	2.2%	0.9%	0.2%	204	0.0%	0.8%	4.6%	4.2%	13.4%	0.0%
	Total	870	40.5%	31.3%	12.3%	9.2%	6.1%	0.6%	890	0.8%	7.1%	19.8%	19.4%	52.8%	0.1%

10.3389/fpsyg.2023.994128

TABLE 2 Two-factor ANOVA and multiple comparisons for daily users.

	Interaction				Riding frequency		Before and during COVID-19
Personal space	*F*-value	28.85***			13.55***		29.78***
	Mean	SD	Mean	SD	Multiple comparisons		Multiple comparisons
	(d) Before		(e) During		(d) Before	(e) During	
(a) Unchanged group	56.11	23.91	57.27	23.69	–	–	(e) > (d) **
(b) Increased group	64.70	22.01	74.36	19.71	(b) > (a) **	(b) > (a) *** (b) > (c)***	(e) > (d) ***
(c) Decreased group	58.54	5.93	56.68	25.95	–	–	–
Time spent with others	*F*-value	18.43***			16.23***		10.15***
	Mean	SD	Mean	SD	Multiple comparisons		Multiple comparisons
	(d) Before		(e) During		(d) Before	(e) During	
(a) Unchanged group	46.81	25.80	46.98	25.95	–	–	–
(b) Increased group	57.57	25.41	63.47	26.66	(b) > (a) *** (b) > (c)***	(b) > (a) *** (b) > (c)***	(e) > (d) ***
(c) Decreased group	43.14	26.26	41.46	26.54	–	–	(d) > (e) *

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

TABLE 3 Two-factor ANOVA and multiple comparisons for Leisure-oriented users.

	Interaction				Riding frequency		Before and during COVID-19
Personal space	*F*-value	20.69***			3.85*		18.82***
	Mean	SD	Mean	SD	Multiple comparisons		Multiple comparisons
	(d) Before		(e) During		(d) Before	(e) During	
(a) Unchanged group	66.39	24.62	68.02	22.93	–	–	–
(b) Increased group	68.02	22.93	76.77	18.80	–	(b) > (a) *** (b) > (c)***	(e) > (d) ***
(c) Decreased group	66.10	23.62	64.17	24.33	–	–	–
Time spent with others	*F*-value	26.34**			3.63*		n.s.
	Mean	SD	Mean	SD	Multiple comparisons		Multiple comparisons
	(d) Before		(e) During		(d) Before	(e) During	
(a) Unchanged group	59.45	26.15	59.26	26.68	–	–	–
(b) Increased group	63.15	26.72	68.06	23.35	–	(b) > (a)* (b) > (c)***	–
(c) Decreased group	60.34	26.25	55.44	26.98	–	–	–

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.
n.s., not significant.

SD = 25.41) was significantly higher than that of the unchanged (M = 46.81, SD = 25.80) and decreased groups (M = 43.14, SD = 26.26). For during the COVID-19 condition, the increased group's mean score before COVID-19 (M = 63.47, SD = 26.66) was also significantly higher than that of the unchanged (M = 46.94, SD = 25.95) and decreased groups (M = 46.46, SD = 26.54).

Multiple comparisons between before and during COVID-19 indicated that the mean score of the increased group during COVID-19 (M = 63.47, SD = 26.66) was significantly higher than that before COVID-19 (M = 57.57, SD = 25.41) at a 0.001 significance level. Concerning the decreased group, the mean scores before and during COVID-19 were not high and were significantly lower during COVID-19 (M = 41.46, SD = 26.54) than before COVID-19 (M = 43.14, SD = 26.26) at a 0.001 significance level. However, the difference in mean scores between these two groups could be small due to the minimal effect size ($\eta 2 = 0.005$) (Cohen, 1988).

Leisure-oriented users

Table 3 and Figures 3, 4 show the results of the two-factor ANOVA and multiple comparisons for the leisure-oriented users. The two-factor ANOVA demonstrated significant differences in the interaction effects for leisure-oriented users regarding the importance

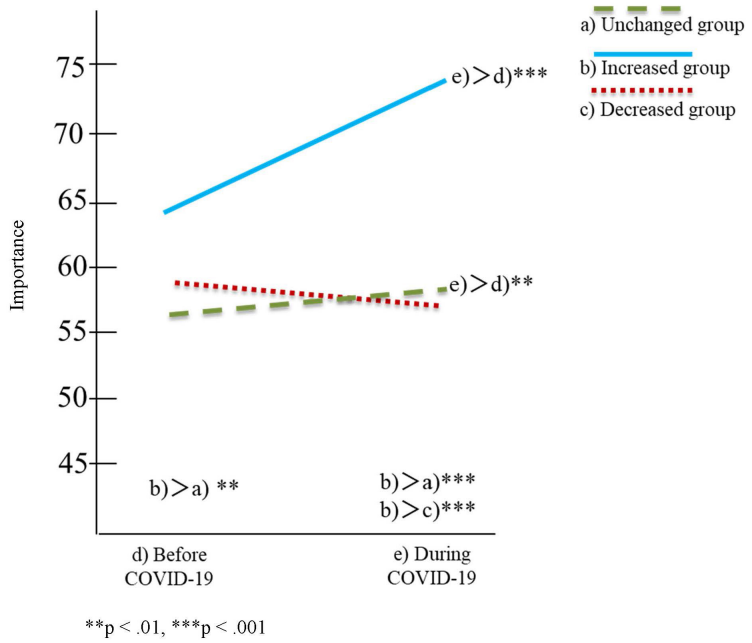

FIGURE 1
Personal space for daily users.

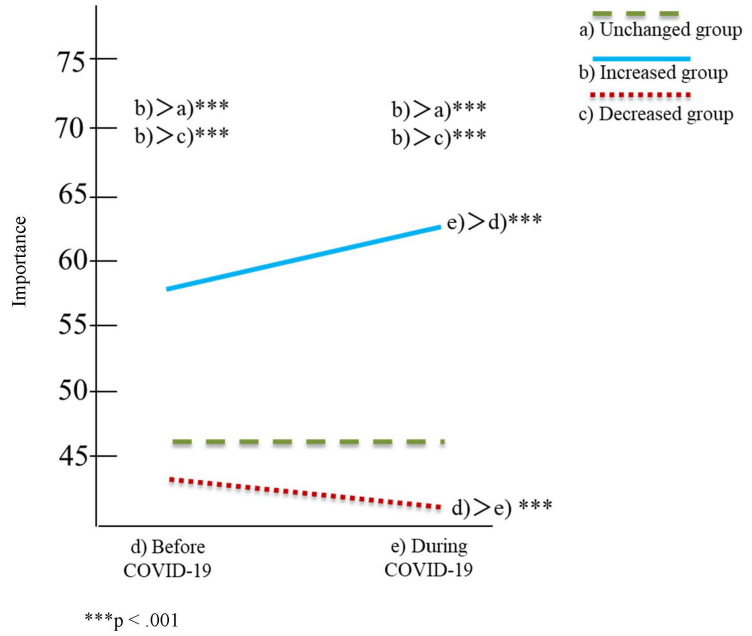

FIGURE 2
Time spent with others for daily users.

of personal space [$F(2,887) = 20.69$, $p < 0.001$] and time spent with others [$F(2,887) = 26.34$, $p < 0.01$]. Regarding personal space, the results of the simple main effect showed significant differences in the motorcycle riding frequency condition [$F(2,887) = 3.85$, $p < 0.05$] and pandemic condition [$F(1,887) = 18.82$, $p < 0.001$]. Significant differences in the mean score of the increased group ($M = 76.77$, SD = 18.80) were only evident during COVID-19. It was significantly higher than the mean scores of the unchanged ($M = 68.02$, SD = 22.93) and decreased groups ($M = 64.17$, SD = 24.33). Multiple comparisons concerning the increased group showed a significant difference between during COVID-19 ($M = 76.77$, SD = 18.80) and before COVID-19 ($M = 68.02$, SD = 22.93).

Regarding the simple main effect analysis for the importance of time spent with others, there were significant differences in the motorcycle riding frequency condition [$F(2,887) = 3.36$, $p < 0.05$]; however, no significant difference was found in the pandemic condition [$F(1,887) = 0.996$, $p = 0.381$, n.s.]. The simple main effect analysis for the increased group indicated that the mean score during

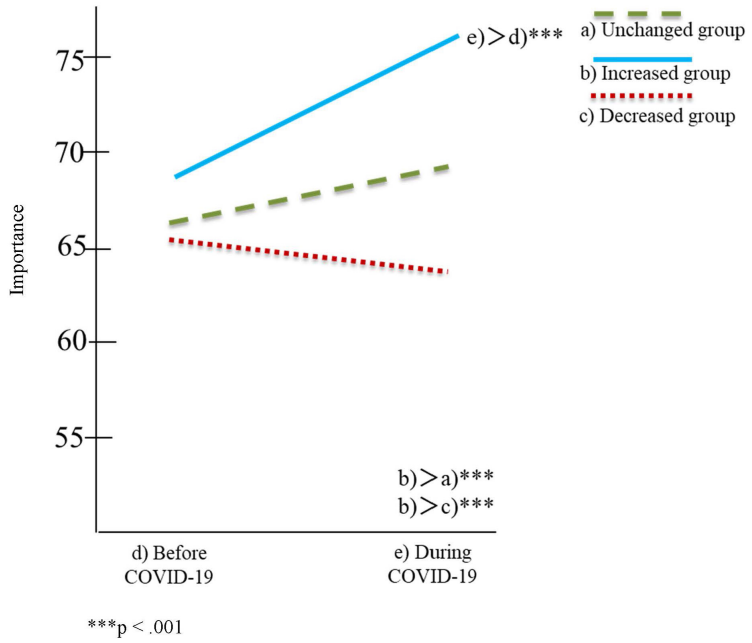

FIGURE 3
Personal space for leisure-oriented users.

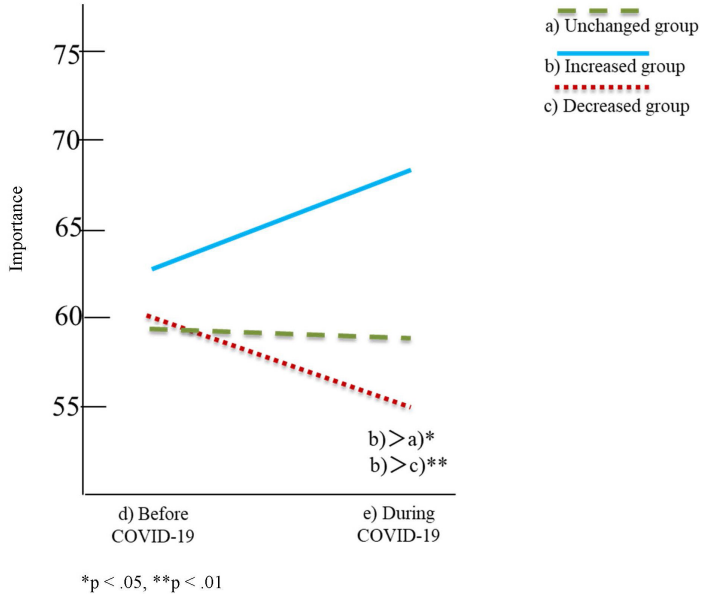

FIGURE 4
Time spent with others for leisure-oriented users.

COVID-19 (M = 68.06, SD = 23.35) was significantly higher than those of the unchanged (M = 59.26, SD = 26.68) and decreased groups (M = 55.44, SD = 26.98).

Discussion

This study clarified whether riding a motorcycle serves as social interaction while practicing social distancing according to motorcyclists' perceptions based on changes in the frequency of riding—unchanged, increased, and decreased—before and during the pandemic. The number of samples in the unchanged group was the highest among the three groups based on the frequency of motorcycle riding. Although respondents of the increased group were few, they perceive riding a motorcycle as necessary for keeping personal space and time spent with others, regardless of their purpose of possessing motorcycles, during the pandemic compared to before it.

Interestingly, while the importance of personal space and time spent with others were stipulated, there were no significant differences across the three groups of leisure-oriented users before

COVID-19, and the importance of personal space for daily users was higher than in the other two groups. As mentioned in the literature review section, people maintain a distance from others that they find pleasant, and they feel uncomfortable when their personal space is invaded (Welsch et al., 2019). Motorcycles as a means of transportation in Asian countries are recognized as avoiding traffic jams, being more effective and efficient in using fuel, easier to buy compared to cars, and more economical than using public transportation (Yamamoto, 2009; Hanafi et al., 2019). Since one's personal space is secured when riding a motorcycle, the survey results may reflect the attitudes of people who ride motorcycles daily. As a motorcycle is a substitute for public transportation for commuting in daily life (Huang et al., 2020; Scorrano and Danielis, 2021), riding a motorcycle could also be beneficial for the increased group to avoid crowded trains. In particular, as the mean score of the increased group during COVID-19 was 10 points higher, riding a motorcycle could be an essential tool for ensuring personal space during the pandemic.

Regarding the importance of time spent with others before COVID-19 for daily users, the mean scores of unchanged and decreased groups were lower than the mid-point of 50. However, the mean scores of the increased group before and during COVID-19 were significantly higher than the other two groups. Hence, daily users may usually ride a motorcycle as daily transportation as well as socializing, compared to the other two groups. Regarding the increased group, the mean scores of time spent with others significantly differed by approximately 20 points from the other two groups during COVID-19. More than 70% of daily users have a motorcycle with a displacement of less than 125cc. This suggests that riding a motorcycle, even one with a small engine, might lead to interaction with others among daily motorcycle users. This may have been more prevalent during the COVID-19 pandemic. The COVID-19 pandemic resulted in a prolonged period of limited social interaction, even within families (Sivan, 2020; Norbury, 2021). This was unprecedented, and the results of this study might be novel in determining the usefulness of motorcycle riding in terms of maintaining personal space and relationships with others.

Half of the leisure-oriented users possessed over 401cc displacement motorcycles, and about 70% of users have more than 251cc displacement motorcycles. According to mean scores for personal space of leisure-oriented users, they may have recognized the importance of personal space obtained from riding a motorcycle before COVID-19. A pandemic could have enhanced its importance in the increased group. In the increased group, although the importance of time spent with others also increased during COVID-19, the mean scores of the three groups were lower than the importance of personal space. Wellbeing related to riding a large-sized motorcycle for leisure-oriented users may have had a stronger connotation to free time and activities for mentally escaping from work, obligations, and other stressors, than for social interactions before COVID-19 (Zijlstra and Sonnentag, 2006; Liu et al., 2022). Its importance may have increased further during COVID-19 to prevent infection.

Motorcycle riding is a leisure activity, and the riding experience enhances the rider's wellbeing (Kruger and Venter, 2020). The results of this study show that motorcycle riding is an effective way to spend time with others while maintaining personal space, a result that many people reaffirmed. Leisurely social interaction is a pivotal time and activity that leads to human wellbeing. Due to the pandemic, people have faced practicing social distancing continually and are compelled to restrict leisure activities. However, this study indicated that motorcycle riding could be a significant mean of practicing social distancing while spending time with others. Motorcycle riding may enable daily transportation and leisure-oriented users to practice social distancing while simultaneously spending time with companions and alleviating loneliness and isolation during the pandemic. When riding a motorcycle, riders are expected to pay sufficient attention to safety and improve their manners in order to control accidents and traffic congestion. But more than that, riding a motorcycle will provide us with various psychological benefits. A study on the psychological benefits of motorcycle riding would provide essential suggestions for post-pandemic lifestyle and leisure activities, ensuring personal space while spending time with others.

Limitations and future research

This study compared the importance of motorcycle riding for personal space and time spent with others before and during COVID-19. For daily transportation and leisure activities, motorcycle riding as personal mobility enables users to practice social distancing and spend time with others, in terms of motorcyclists who increased their motorcycle riding frequency. Our findings might contribute to human wellbeing through two-wheel personal mobility. However, this study has some limitations.

First, although this study indicated the importance of personal space and time spent with others by comparing before and during COVID-19, the specific reasons for this importance are still unclear. The psychological and behavioral aspects of the riders could undeniably be affected by several factors, such as particular occasions or legal regulations. Research clarifying the reasons and triggers for increasing motorcyclists' personal space and time may be necessary while considering the factors influencing their motorcycle riding.

Second, the terms for personal space and time spent in this study relied on respondents' interpretations. Occasions involving social interactions may have varied. This study was not limited to either riding alone or with others. Additionally, social interaction could imply riding with two people and interacting with other motorcyclists. Some motorcyclists form brand communities of particular motorcycle manufacturers (Marzocchi et al., 2013). However, this study did not discuss the types of interactions. Thus, future studies are required to understand the specific social interactions and the meaning of personal space induced by riding motorcycles. We did not consider information regarding passengers in the present study. Riders can be divided into two categories: those who ride alone and those who go touring in groups. Since about 80% of riders in Japan ride solo, especially men, we assumed that most participants in this study ride solo (Japan Automobile Manufacturers Association, Inc [JAMA], 2022). In future studies, it will be necessary to examine the effects of difference in terms of passenger on personal space and social interaction.

Finally, as Japan did not implement lockdowns for behavior restrictions, the riding frequency was measured according to personal perception. However, we did not include the respondents' relationship with motorcycles, such as their riding history and experiences or how long they have owned motorcycles. Depending on their psychological and behavioral relationships with motorcycles, the importance of motorcycles during COVID-19 may differ. Research

is consequently required to examine the perceived importance of riding a motorcycle for motorcycle users before and after COVID-19 to secure personal space and time, as well as activities for social interactions. Additionally, the importance and kind of values remain unclear for motorcyclists. Research that illustrates motorcycles as personal mobility and how they contribute to the wellbeing of humans could thus be essential.

Data availability statement

The original contributions presented in this study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

YW conceived and designed the research and wrote the first draft of the manuscript. YB wrote sections of the manuscript. MI supervised the work. All authors have read and approved the manuscript.

Funding

This study was conducted as part of collaborative research (Kando project) with Yamaha Motor Co., Ltd., and Ritsumeikan University. Yamaha Motor Co., Ltd., was not involved in the study design, collection, analysis, interpretation of data, the writing of this article, or the decision to submit it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Altman, I., and Vinsel, A. M. (1977). "Personal space," in *Human behavior and environment*, eds I. Altman and J. F. Wohlwill (Boston, MA: Springer), 181–259.

Bielewicz, J., Daniluk, B., and Kamieniak, P. (2022). VAS and NRS, same or different? Are visual analog scale values and numerical rating scale equally viable tools for assessing patients after microdiscectomy? *Pain Res. Manag.* 2022:5337483. doi: 10.1155/2022/5337483

Bijur, P. E., Silver, W., and Gallagher, E. J. (2001). Reliability of the visual analog scale for measurement of acute pain. *Acad. Emerg. Med.* 8, 1153–1157. doi: 10.1111/j.1553-2712.2001.tb01132.x

Brazier, J., Green, C., McCabe, C., and Stevens, K. (2003). Use of visual analog scales in economic evaluation. *Expert Rev. Pharmacoecon. Outcomes Res.* 3, 293–302. doi: 10.1586/14737167.3.3.293

Carter, C. I. (2017). Tourism on two wheels: Patterns of motorcycle leisure in Wales. *Tour. Manag.* 61, 180–189. doi: 10.1016/j.tourman.2017.02.007

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*, 2nd Edn. Hillsdale: Lawrence Erlbaum Associates.

Crowther, G. (2011). Sustainable motorcycling: Rethinking mobility, consumption and market relationships. *Int. J. Motorcycle Stud.* 7, 1–6.

Frash, R. E. Jr., and Blose, J. E. (2019). Serious leisure as a predictor of travel intentions and flow in motorcycle tourism. *Tour. Recreat. Res.* 44, 516–531. doi: 10.1080/02508281.2019.1626118

Funke, F., and Reips, U. D. (2012). Why semantic differentials in web-based research should be made from visual analogue scales and not from 5-point scales. *Field Methods* 24, 310–327. doi: 10.1177/1525822X12444061

Gérin-Lajoie, M., Richards, C. L., Fung, J., and McFadyen, B. J. (2008). Characteristics of personal space during obstacle circumvention in physical and virtual environments. *Gait Posture* 27, 239–247. doi: 10.1016/j.gaitpost.2007.03.015

Hanafi, M. A. N., Kamase, J., Djamereng, A., and Serang, S. (2019). The effect of brand awareness and quality perception of customer satisfaction through purchasing decisions honda and yamaha motors: Case study of maros muslim university students. *Bus. Econ. Res.* 9, 210–230. doi: 10.5296/ber.v9i4.15561

Hartnett, J. J., Bailey, K. G., and Gibson, F. W. Jr. (1970). Personal space as influenced by sex and type of movement. *J. Psychol.* 76, 139–144. doi: 10.1080/00223980.1970.9916831

Hecht, H., Welsch, R., Viehoff, J., and Longo, M. R. (2019). The shape of personal space. *Acta Psychol.* 193, 113–122. doi: 10.1016/j.actpsy.2018.12.009

Holt, D. J., Cassidy, B. S., Yue, X., Rauch, S. L., Boeke, E. A., Nasr, S., et al. (2014). Neural correlates of personal space intrusion. *J. Neurosci.* 34, 4123–4134. doi: 10.1523/JNEUROSCI.0686-13.2014

Huang, J., Wang, H., Fan, M., Zhuo, A., Sun, Y., and Li, Y. (2020). "Understanding the impact of the COVID-19 pandemic on transportation-related behaviors with human mobility data," in *Proceedings of the 26th ACM SIGKDD international conference on knowledge discovery & data mining*, (Beijing), 3443–3450. doi: 10.1145/3394486.3412856

Hudson, N. W., Lucas, R. E., and Donnellan, M. B. (2020). Are we happier with others? An investigation of the links between spending time with others and subjective well-being. *J. Personal. Soc. Psychol.* 119, 672–694. doi: 10.1037/pspp0000290

IBM Corp (2020). *IBM SPSS statistics for macintosh, version 27.0 [Computer software]*. Armonk, NY: IBM Corp.

Japan Automobile Manufacturers Association, Inc [JAMA] (2022). *The 2021 motorcycle market trend survey*. Available online at: https://www.jama.or.jp/release/docs/release/2022/20220420_2021Motorcycle.pdf [in Japanese] (accessed Nov 10, 2022).

Japan Professional Football League (2020). *League™ fan survey 2019 summary report*. Available online at: https://www.jleague.jp/docs/aboutj/funsurvey-2019.pdf [in Japanese] (accessed Nov 23, 2022).

Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukophadhyay, T., and Scherlis, W. (1998). Internet paradox: A social technology that reduces social involvement and psychological well-being? *Am. Psychol.* 53, 1017–1031. doi: 10.1037/0003-066X.53.9.1017

Kruger, S., and Venter, D. (2020). I can't buy happiness but could own a motorcycle: Does leisure life matter. *Afr. J. Hosp. Tour. Leis.* 9, 469–483. doi: 10.46222/ajhtl.19770720-31

Kyodo News (2022). *Motorcycle shipments in Japan appear to have hit 23-yr high amid pandemic*. Available online at: https://english.kyodonews.net/news/2022/01/1938685bd262-motorcycle-shipments-in-japan-appear-to-have-hit-23-yr-high-in-2021.html (accessed June 24, 2022).

Liu, H. L., Lavender-Stott, E. S., Carotta, C. L., and Garcia, A. S. (2022). Leisure experience and participation and its contribution to stress-related growth amid COVID-19 pandemic. *Leis. Stud.* 41, 70–84. doi: 10.1080/02614367.2021.1942526

Marzocchi, G., Morandin, G., and Bergami, M. (2013). Brand communities: Loyal to the community or the brand? *Eur. J. Mark.* 47, 93–114. doi: 10.1108/03090561311285475

Newman, D. B., Tay, L., and Diener, E. (2014). Leisure and subjective well-being: A model of psychological mechanisms as mediating factors. *J. Happiness Stud.* 15, 555–578. doi: 10.1007/s10902-013-9435-x

Norbury, R. (2021). Loneliness in the time of COVID. *Chronobiol. Int.* 38, 817–819. doi: 10.1080/07420528.2021.1895201

O'Brien, W., Lloyd, K., and Riot, C. (2017). Exploring the emotional geography of the leisure time physical activity space with mothers of young children. *Leis. Stud.* 36, 220–230. doi: 10.1080/02614367.2016.1203353

Scorrano, M., and Danielis, R. (2021). Active mobility in an Italian city: Mode choice determinants and attitudes before and during the COVID-19 emergency. *Res. Transp. Econ.* 86:101031. doi: 10.1016/j.retrec.2021.101031

Sivan, A. (2020). Reflection on leisure during COVID-19. *World Leis. J.* 62, 296–299. doi: 10.1080/16078055.2020.1825260

Sommer, R. (1959). Studies in personal space. *Sociometry* 22, 247–260. doi: 10.2307/2785668

Stebbins, R. A. (1997). Casual leisure: A conceptual statement. *Leis. Stud.* 16, 17–25. doi: 10.1080/026143697375485

Stokburger-Sauer, N. (2010). Brand community: Drivers and outcomes. *Psychol. Mark.* 27, 347–368. doi: 10.1002/mar.20335

van Leeuwen, M., Klerks, Y., Bargeman, B., Heslinga, J., and Bastiaansen, M. (2020). Leisure will not be locked down–insights on leisure and COVID-19 from the Netherlands. *World Leis. J.* 62, 339–343. doi: 10.1080/16078055.2020.1825255

Walker, L. (2010). "Tourism and leisure motorcycle riding," in *Drive tourism: trends and emerging markets*, eds B. Prideaux and D. Carson (New York, NY: Routledge), 146–158.

Welsch, R., von Castell, C., and Hecht, H. (2019). The anisotropy of personal space. *PLoS One* 14:e0217587. doi: 10.1371/journal.pone.0217587

Yamamoto, T. (2009). Comparative analysis of household car, motorcycle and bicycle ownership between Osaka metropolitan area, Japan and Kuala Lumpur, Malaysia. *Transportation* 36, 351–366. doi: 10.1007/s11116-009-9196-x

Zijlstra, F. R., and Sonnentag, S. (2006). After work is done: Psychological perspectives on recovery from work. *Eur. J. Work Organ. Psychol.* 15, 129–138. doi: 10.1080/13594320500513855

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 08 March 2023
DOI 10.3389/fpsyg.2023.1094536

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OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Personality and Social Psychology, a section of the journal Frontiers in Psychology

RECEIVED 10 November 2022
ACCEPTED 20 February 2023
PUBLISHED 08 March 2023

CITATION
Wang Y, Yao T and Qiu Q (2023) From experience to expectation: The reverse effect of power on purchasing impulsiveness. *Front. Psychol.* 14:1094536. doi: 10.3389/fpsyg.2023.1094536

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From experience to expectation: The reverse effect of power on purchasing impulsiveness

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Introduction: Previous literatures have mainly explored the impact of the experience of power on impulsive buying, but have ignored the impacts of the expectations of power. The purpose of this research is to delineates a two-facet portrait of power in the role of affecting purchase impulsiveness by proposing a theoretical extension from the experience of power to the expectations of power.

Methods: Four laboratory experiments were developed that used ANOVA to verify the hypothesis. A moderated mediation path model was established including the experience of power, product attribute, the expectations of power, deservingness, and purchasing impulsiveness as observed variables.

Results: The results revealed that powerless consumers are more likely to impulsively buy hedonic products; while powerful consumers prefer to impulsively buy utilitarian products. However, when focusing on the expectations of power, powerless consumers feel a lower perception of deservingness, which reduces their impulse to buy hedonic products. In contrast, when powerful consumers imagine how powerful people should behave in consumption, they will experience a higher sense of deservingness and increase purchasing impulsiveness for hedonic products. The underlying mechanism is that deservingness plays a mediation role in the three-way interaction impacts of the experience of power, product attribute, and the expectations of power on purchasing impulsiveness.

Conclusion: The current research formulates a new theoretical perspective on the relationship between power and purchasing impulsiveness. An experience-expectation model of power is presented that proposes consumers' purchasing impulsiveness can be affected both by the experience of power and the expectations of power.

KEYWORDS

impulsive purchase, power, power expectation, deservingness, normative assessment

Introduction

Impulse buying is a pervasive and distinctive aspect of consumers' lifestyles and also a focal point of considerable marketing management activity (Rook, 1987). The data show that it accounts for as much as 62% of traditional supermarket sales and 80% of all sales in certain product categories (Luo, 2005), within the huge e-commerce market, consumers

often make spontaneous, unplanned, unreflective, and unthoughtful impulse purchases (Habib and Qayyum, 2018). Reports from Internet Retailer (2019) indicated that Alibaba and Amazon jointly created a huge sales volume of $1.13 billion in 2018 (Li et al., 2021), of which impulse purchases contributed a large portion of sales. Scholars from different disciplinary backgrounds have explored the drivers of impulsive buying (Luo, 2005; Amos et al., 2014; Chen and Ku, 2021; Li et al., 2021; Chen et al., 2022), especially the impacts of some psychological characteristic such as ability to regulate emotion (Li et al., 2017), anticipated regret (Li et al., 2021), and susceptibility to influence (Luo, 2005).

As a key psychological factor, it seems that the power takes a leading position in impulsive buying behavior. The notion of power is a critical dimension of the judgments or decisions to be made (Li et al., 2022), having or lacking power has transformative effects on consumers' information processing and decision-making (Keltner et al., 2003; Rucker and Galinsky, 2008; Rucker et al., 2012; Garbinsky et al., 2014). Scholars consistently document the importance of the experience of power in influencing impulsive buying (e.g., Keltner et al., 2003; Smith and Trope, 2006; Jin and Zhu, 2016), but the studies have not achieved a convergent conclusion. Construal level theory, for example, suggests that power increases psychological distances which enable powerful people to make decisions at high construal level, as a consequence, powerful people are not easy to buy impulsively (Smith and Trope, 2006). Empirical researches on self-control (Jia et al., 2020) and saving behavior (Garbinsky et al., 2014) can provide supports. A second line of research based on the power-approach theory (Keltner et al., 2003) suggests that power activates a general tendency to approach whereas powerlessness activates a general tendency to inhibit. As a result, people having power are more likely to purchase products impulsively, while those lacking power are less likely to be impulsive in consumption behavior (Galinsky et al., 2003). A third effort to understand the experience of power has examined the link between power and the types of products purchased on impulse. Jin and Zhu (2016) proposed that powerful individuals are more likely to buy utilitarian products on impulse, while powerless individuals are more likely to buy hedonic products on impulse. The mechanism is that the fluency of information processing leads consumers to consider that their impulse purchase decisions are correct. This mechanism is not exactly the same as the impulsive purchase phenomenon in which consumers encounter the internal psychological conflict of whether or not to buy. Although impulsive buying often occurs spontaneously, it is not a completely uncontrollable behavior, but the result of the failure of self-control caused by desire over willpower (Hoch and Loewenstein, 1991; Baumeister, 2002).

In sum, previous power literature commonly explores the impact of the experience of power on impulsive buying. However, power is accompanied by both an experience (the internal psychological and physiological tendencies that activate when one has or lacks power) and expectations (schemas and scripts that related to how people in a given position of power behave) (Rucker et al., 2014). The expectations of power are related to social stereotype of power. In fact, individuals often observe how people with or without power should behave in society, and hold a series of schemas and scripts related to power. Under Chinese culture, high power individuals are perceived to be more capable (Wang et al., 2017), power stereotypes play an important role in consumers' decision-making (Zhang et al., 2015; Wang et al., 2017; Li et al., 2022). A focus on the expectations of power might yield distinct and novel effects on consumer decision-making (Rucker et al., 2014). Despite the importance of this variable, to our knowledge, scholars have rarely explored whether the expectations of power will have a different effect on the purchase impulsiveness compared to the experience of power.

In this research, we build on previous research on the expectations of power (Rucker et al., 2014; Wang et al., 2017) to suggest that reminders of the expectations of power promote a normative evaluation of purchase impulsiveness, which guides consumers' decision making toward impulsive buying (Rook and Fisher, 1995; Kivetz and Zheng, 2017). Theoretically, we propose an associative mechanism to suggest that high power is associated with greater "I deserve" in the face of hedonic product temptations. This associative account, as we describe subsequently, is consistent with the idea that activating the expectations of power triggers the justification of impulsive buying. When normative evaluation of impulse buying is activated through salient low deservingness, powerless individual is less likely to engage in hedonic impulsive buying. Consequently, focused on the social stereotype of powerless or powerful people, people with low power tend to reduce the impulse desire to buy hedonic product, on the contrary, people with high power will increase their impulsive desire to buy hedonic products.

Our findings add to the literature in several important ways, we are the first to examine the impact of the expectations of power on the impulse to buy hedonic products. Meanwhile, this research proposes a theoretical research framework including the dual perspectives of the experience of power and the expectations of power, which can integrate the existing contradictory research results on the relationship between power and impulse purchase. In addition, we identify the sense of deservingness as a heretofore unexamined process underlying the influence of engaging in the expectations of power on purchase impulsiveness. Taken together, our results suggest that consumers derive the justification of impulse buying of hedonic products when they shift the focus from the experience of power (how I feel) to the expectations of power (how I should behave), their impulse willingness to buy hedonic products is related to the results of normative evaluation.

Literature review and research hypotheses

The experience of power versus the expectations of power

Power refers to the capacity to influence other people, it emerges from control over valuable resources and the ability to administer rewards and punishments (Keltner et al., 2003). Power is often conceived of as a structural variable and as a property of social relationships, can also become a psychological property of the individual (Galinsky et al., 2003). First, power refers to the ability of an individual to be independent or not be affected by others. Second, power is related to long-term social status, economic status, and perception of controlling over others related to one's position in an organization. "By creating a rank-ordering collection of

individuals, power serves as a social tool to organize and structure individuals and groups" (Rucker et al., 2014). Besides, in the temporary perspective, power is a psychological variable which means that people can feel powerless or powerful independent of their structural position (Rucker et al., 2014). For example, recalling a previous episode in which people felt powerless or powerful alters their sense of power. Therefore, the sense of powerless or powerful could be primed by context, role or memory of experienced state of powerless or powerful (Magee and Galinsky, 2008).

A great deal of research has argued that possessing power could produce a variety of effects ranging from perception of price unfairness (Jin et al., 2014), consumer's feeling of controlling over inanimate objects (Kim and McGill, 2011), preference for small or large objects (Dubois et al., 2012), and consumer's information processing and status seeking behavior (Rucker et al., 2014). Compared with powerful consumers, consumers who are lack of power may have less sense of control and have negative emotional experiences (Berdahl and Martorana, 2006). Therefore, in order to restore the control and get rid of negative experiences, the compensatory consumer behavior is produced, especially for buying high social-status products (Rucker and Galinsky, 2008; Rucker et al., 2012). On the contrary, an individual with high-power pays more attention to the utility of the product, and emphasis more on the quality and performance of the product rather than the symbolic meaning (Jin and Zhu, 2016). Meanwhile, the power affects consumer's focus on goals and values. According to the Agentic-Communal Orientation Theory of power, people with high-power have agentic orientations, and they are more self-focused and this leads them to be less charitable (Han et al., 2017), willing to purchase products for themselves (Rucker et al., 2011). However, powerless individuals are more community orientated. Specifically, they pay more attention to others' needs (Piff et al., 2010), and spend more for others (Rucker et al., 2011). Finally, the power experience has an effect on consumer's behavioral tendency. According to the "Approach/Inhibition" Theory of power, an increase in power experience will activate individuals' approach behavior and make them easier to perceive information such as rewards and success; while, a decrease in power experience will activate the inhibition behavior, and it is easier for individuals to perceive more information on threats and failures (Inesi, 2010).

It is worth noting that the possession of power is not accompanied only by the psychological experience. People often observe how the powerful and the powerless behave, they may come to hold a variety of expectations for the roles tied to different levels of power. The expectations of power are defined as the cognitive associations or schemas people have regarding how people behave based on their position of power (Rucker et al., 2014). The psychological experience of power refers to how one feels, and the expectations of power concentrate on how people with different power should behave in their actions. The expectations of power reflect organized knowledge structures and beliefs about how people should behave based on a role, can also guide consumer decision. For example, Rucker et al. (2014) found that powerful people would be more willing to choose status-related products which match their high-power experience when they are expected to be decent. People can behave in a manner consistent with the cognitive associations tied to a particular construct or role because those schemas become more accessible in one's mind.

Despite the plethora of research that has examined how the psychological experience of power influences consumer behavior. For example, previous research has examined the impact of power on consumer's goal pursuit (Chen J. et al., 2014), information processing (Smith and Trope, 2006; Chen J. E. et al., 2014), and consumption decision (Rucker et al., 2012; Garbinsky et al., 2014). However, to our best knowledge, the relationship between the expectations of power and impulsive buying remains relatively unexplored. we introduce the notion that power is accompanied by both an experience and expectations. As a consequence, for the same individual, focusing on the experience of power may produce a given set of effects on impulsive buying, whereas focusing on expectations of power may sometimes elicit a different desire to purchase.

The experience of power and purchase impulsiveness

Lacking power is an aversive state and thus individuals are often motivated to reduce a state of powerlessness (Rucker and Galinsky, 2008). Consumers with low-power experience are eager to get rid of this negative psychological feeling in various ways, including compensating consumption (Chen et al., 2017). A focus on one's internal psychological experience of power produces a focus on what a product will do for an individual (Rucker and Galinsky, 2009), as a result, hedonic products were predicted to be particularly valued by the powerless as a means of elevating a negative feeling. In addition, people with low power have less self-regulatory resources, while selection and self-regulation can consume the internal resources of individuals (Baumeister et al., 1998). Powerless are more dependent on emotions for making decision due to their limited cognitive processing resources (Shiv and Fedorikhin, 1999). When people rely on emotions to make decisions, it is easier for them to purchase hedonic products (Jin and Zhu, 2016). Both limited cognitive ability and negative experience cause people with low power more likely to buy hedonic products on impulse than utilitarian ones.

On the contrary, individuals with high-power experience will have a stronger sense of control because they could control more valuable resources (Berdahl and Martorana, 2006). Hence, they have less psychological demand for compensatory consumption. In terms of the choice of product features, people with a high sense of power pay less attention to the symbolism of the product, but more to the functional value of the product (Magee and Galinsky, 2008). High power leads to a preference for products that provide individuals with the greatest utility (Rucker and Galinsky, 2009). Prior study has confirmed that when focusing on the psychological experience of power, consumers with high power are more likely to have impulsive desire for utilitarian products (Jin and Zhu, 2016). Thus, we hypothesize that:

> Hypothesis 1: Consumers with high-power experience have stronger impulsiveness to purchase utilitarian product than hedonic product.

> Hypothesis 2: Consumers with low-power experience have stronger impulsiveness to purchase hedonic product than utilitarian product.

The expectations of power and purchase impulsiveness

There are a number of reasons why the expectations of power may weaken powerless individuals' desires for hedonic products. First, according to the "desire-willpower" theory of impulsive buying (Hoch and Loewenstein, 1991), When consumers have a time-inconsistent preference, they will experience the process of psychological conflict and struggle between purchase desire and willpower. Consumers will evaluate the reasonableness of their impulsive purchase of hedonic products (Rook and Fisher, 1995). In fact, consumers who have the desire to buy may not really make impulsive purchases, and there are no uncontrollable impulses in the world (Rook, 1987), Impulse buying is caused by the failure of self-control, and it is not a completely unthinking and uncontrollable behavior of consumers in essence (Baumeister, 2002).

Second, social stereotypes generally believe that people with low power should be more economical in their daily life because they have less valuable resources, and there is no need to consume unnecessary hedonistic products (Magee and Galinsky, 2008). When focusing on the expectations of power, the schemas and scripts about lacking power become more accessible in powerless peoples' mind, they will not find a "reasonable" reason to buy hedonic products on impulse. Hedonistic products are mainly characterized by aesthetic and emotional experience, although they can bring immediate satisfaction to consumers (Pang et al., 2014), compared with utilitarian products characterized by instrumentality and functionality, it is difficult for consumers to prove the reasonableness of purchase (Dhar and Wertenbroch, 2012). Consumers will pay attention to hedonistic needs only after the necessary functional needs have been met, unless they can prove that they have the right to indulge (Chitturi et al., 2008). Powerless individuals have less quantity of valuable resources, and limited resources should be used to meet basic functional needs. When they are unable to prove the rationality of choosing pleasure goods, they are naturally unwilling to indulge themselves to consume hedonic products (Levav and McGraw, 2009).

In contrast, when high power individuals think about how powerful people should spend from the perspective of other people in society, they will find that social stereotypes generally believe that people with high power have more valuable resources, so they are more qualified and able to have fun, and should engage in consumer behavior consistent with their high power (Magee and Galinsky, 2008). The activation of schemas and scripts of powerful people leads to a spreading activation of constructs that can nudge high power people's behavior in a manner consistent with those schemas. Thus, People with a high sense of power will think that it is very reasonable for them to consume hedonic products on impulse. Accordingly, we propose two specific hypotheses:

> Hypothesis 3: When the expectations of power are activated, consumers with low-power experience will reduce impulsiveness to purchase hedonic product.

> Hypothesis 4: When the expectations of power are activated, consumers with high-power experience will increase impulsiveness to purchase hedonic product.

Deservingness

Deservingness inherently refers to a rationale for why someone is worthy of a particular outcome or treatment (Cavanaugh, 2014). As an important source of justification of consumption, deservingness often appears in advertisements. For example, firms often appeal to consumers' sense of deservingness to encourage their consumption behavior with slogans such as "you deserve to have this good car" (GM), "today, you deserve to have a rest" (McDonald's), and "you deserve it" (L'Oréal).

Research has proved that deservingness affects people's indulgent consumption behavior (Xu and Schwarz, 2009). In the consumption research domain, impulsive behavior has been linked with "being bad" and with negative consequences in the areas of personal finance, post-purchase satisfaction, social reactions, and overall self-esteem (Rook and Fisher, 1995). Consumers who have purchase impulsiveness need to conduct a normative evaluation, i.e., judgments about the appropriateness of engaging in impulsive purchasing behavior (Rook and Fisher, 1995). Hedonic products can bring instant gratification compared with utilitarian products, but it is difficult to prove the normalization of hedonic consumption (Dhar and Wertenbroch, 2012). Compared with utilitarian purchase, consumers would provide more convincing proofs of justification for hedonic purchase (Khan and Dhar, 2010). On the contrary, utilitarian products which satisfy basic needs can naturally prove consumer's justification (Kivetz and Zheng, 2017). Indulging with a reason refers to a rational or justified indulgence that feels like it is earned or deserved (Xu and Schwarz, 2009). For example, Kivetz and Simonson (2002) found that consumers are more likely to choose hedonic returns rather than practical returns if hedonic rewards require more efforts, because these efforts make them believe that they have the right for indulgence. Kivetz and Zheng (2006) found that people who work hard or exceed their tasks are more likely to choose hedonic products as rewards because they have logical reasons for their indulgent consumption. Kivetz and Zheng (2017) found that price promotion provides reasonable proofs for hedonic consumption compared with quantity discounts, and a consumer will think "I have the power to do so." In contrast, Cavanaugh (2014) found that when people are reminded that they don't possess a valuable relationship, deservingness would be reduced and thereby constrain their indulgent consumption.

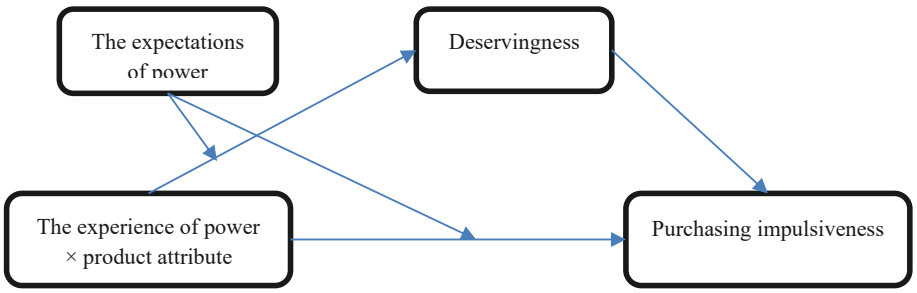

FIGURE 1
Conceptual diagrams of model.

On the basis of existing research, we propose that powerless people who make their impulsive purchase decisions through the observation of other's behavior have a low sense of deservingness, and they cannot prove the justification of impulsively purchasing hedonic products. On the contrary, when power expectation is activated, the scripts and schemas about how powerful people consume goods increase their attention to hedonic products, and powerful people will feel that they are qualified and capable, that is, they are worth buying hedonistic products, thus providing a reasonable cause for hedonistic consumption. The conceptual diagrams of model are shown in Figure 1. Thus, we suggest the following:

> Hypothesis 5: When power expectation is activated, consumers with low-power experience will have lower sense of deservingness, whereas consumers with high-power experience will have higher sense of deservingness.

> Hypothesis 6: When power expectation is activated, deservingness plays a mediation role in the impact of power experience on impulsiveness to purchase utilitarian product versus hedonic product.

Study design

Study 1: The experience of power and purchase impulsiveness

The goal of study 1 was to test the H1 and H2. We manipulated subjects' power experience and product attributes, and then asked them to response their impulsive purchase intention for utilitarian or hedonic products.

Pretest

First, consistent with prior work (Galinsky et al., 2003), we manipulated power experience consisting of an episodic recall task that asks subjects (under graduation students, $N = 54$) to recall an event in which either they have power over someone else (high power) or someone else have power over them (low power). The existing study has verified that this method has good reliability and validity (Rucker and Galinsky, 2008). After the manipulation, subjects were asked to report their power experience in a seven-point item "how powerful did you feel when completing the recall task?" (1 = not powerful at all, 7 = very powerful). At the same time, the subjects were asked to answer "to what extent you engaged in the episodic recall task?" (1 = not at all engaged, 7 = very much engaged). The results showed that all subjects could focus on power experience scenario ($M = 6.13$, $SD = 0.65$). Meanwhile, subjects in the high-power context reported their feelings were significantly more powerful ($M = 5.26$, $SD = 1.26$) than those in the low-power context ($M = 3.07$, $SD = 0.96$, $F(1, 52) = 51.541$, $p < 0.001$), indicating a successful manipulation of power experience.

Second, we chose portable music player as the stimulus material and manipulated its hedonic and utilitarian attributes (Pang et al., 2014). Here, the "hedonic attribute" refers to the aesthetic, experiential, and enjoyment-related benefits; and "utilitarian attribute" refers to the functional, instrumental, and practical benefits of consumption offerings (Chitturi et al., 2007). Subjects (under graduation students, $N = 22$) were asked to evaluate four important product attributes of a music player, including two hedonic attributes (appearance: changeable color; sound quality: high quality stereo audio) versus two utilitarian attributes (battery capacity: 20 h endurance; manipulative mode: control by earphone wire). They reported their feelings of each attribute with two seven-point items: "to what extent you think it is the hedonic (utilitarian) attribute of the music player" (1 = strongly disagree, 7 = strongly agree) (Chitturi et al., 2007). The results demonstrated that the battery capacity ($M_{hedonic} = 3.09$, $SD = 0.75$ vs. $M_{utilitarian} = 6.41$, $SD = 0.67$, $t(21) = 16.461$, $p < 0.001$) as well as manipulative mode ($M_{hedonic} = 3.14$, $SD = 0.71$ vs. $M_{utilitarian} = 6.45$, $SD = 0.67$, $t(21) = 21.730$, $p < 0.001$) were more utilitarian, and appearance ($M_{hedonic} = 5.91$, $SD = 0.68$ vs. $M_{utilitarian} = 3.14$, $SD = 0.94$, $t(21) = 10.241$, $p < 0.001$) as well as sound quality ($M_{hedonic} = 5.95$, $SD = 0.72$ vs. $M_{utilitarian} = 5.27$, $SD = 0.87$, $t(21) = 12.396$, $p < 0.001$) were more hedonic, indicating a successful manipulation of product attribute. Subjects also rated the importance of each attribute with a seven-point item: "to what extent you think this attribute is important for you to decide to buy this music player?" (1 = not important at all, 7 = very important). The results showed that there were no significant differences among four attributes ($F(3, 84) = 0.548$, $p = 0.651$).

Design and procedure

A total of 108 undergraduate students (M_{age} = 20.53, SD = 1.38, 56.82% females) in a university participated in the study for course credit. Subjects were randomly assigned to one of four conditions in a 2 (the experience of power: high vs. low) × 2 (product attribute: hedonic vs. utilitarian) between-subjects design. Firstly, we manipulated the experience of power with the same method used in the pretest study. After the manipulation of power, the subjects reported their mood with two seven-point items: "now, I feel sad (or happy)" (1 = strongly disagree, 7 = strongly agree). Subjects didn't feel different positive affect [$M_{high-power}$ = 4.19, $M_{low-power}$ = 4.28, $F(1, 106) = 0.27$, $p < 0.605$, ns] or negative affect [$M_{high-power}$ = 2.74 vs. $M_{low-power}$ = 2.65, $F(1, 106) = 0.29$, $p < 0.592$, ns] in different power contexts, indicating that the experience of power had no effect on subjects' mood. The results were consistent with the previous studies (Galinsky et al., 2003; Smith and Trope, 2006).

Then, we adopted the impulsive purchase scenario designed by Rook and Fisher (1995): Someone was going to buy a product, but occasionally met another ideal product. Under the condition of limited funds, how to make a choice in face of temptation could be viewed as the impulsive purchase. Subjects were exposed to the scenario:

> A few days ago, you got a part-time job salary of ¥500 ($1 = ¥6.9) which you could control freely. Now, you need to buy a calculator necessary in your mathematics course. At the end of the week, you go to the shopping mall with the money and a credit card to buy the calculator (priced at about ¥100). But when you walk through the mall, you find a portable music player (priced at ¥399) is selling fantastically. You like it very much.

Meanwhile, the manipulations of two different product attributes in different designs were same to the pretest study.

After reading this scenario, in order to assess the purchase impulsiveness, subjects were instructed to select which one of five purchase decision alternatives they would make. These choice alternatives were designed to represent varying levels of purchase impulsiveness. From low to high impulsiveness, these alternatives were: (1) buying the calculator only, (2) wanting the portable music player but not buying it, (3) deciding not to buy the calculator, (4) buying both the calculator and the portable music player with the credit card, and (5) buying these plus a matching earphone with the credit card. This method was used and verified to effectively measure the purchase impulsiveness by many previous studies (e.g., Rook and Fisher, 1995; Luo, 2005). The impulsiveness of each purchase alternative was validated with an independent sample of students (under graduation students, N = 89). They were asked to rate the impulsive of each purchase alternative on a seven-point scale, the results showed that there are significant differences in the scores of impulsiveness of purchase between groups [$F(4, 84) = 67.609$, $p < 0.001$; M_1 = 1.41, SD = 0.51; M_2 = 2.29, SD = 0.69; M_3 = 3.30, SD = 0.73; M_4 = 3.94, SD = 0.90; M_5 = 5.11, SD = 0.76]. Counter to our expectation, not buying the calculator was viewed as more impulsive than either buying them only or wanting the portable music player. Because the script was described as planning to buy the calculator, some respondents appeared to view the change of plans as impulsive.

Results

Manipulation check

As expected, subjects in the high-power condition reported that their feelings were significantly more powerful (M = 5.20, SD = 1.04) than those in the low-power condition [M = 3.28, SD = 1.14, $F(1, 106) = 84.53$, $p < 0.001$], indicating a successful manipulation of power experience. Likewise, the results of manipulation check for product attribute priming were almost identical to the pretest study, indicating a successful manipulation of product attribute.

Purchase impulsiveness

The results of ANOVA analysis showed that the main effect of the experience of power on purchase impulsiveness was not significant [$F(1, 104) = 0.235$, $p < 0.629$]. The main effect of product attribute on purchase impulsiveness was also not significant [$F(1, 104) = 0.390$, $p < 0.534$]. But the interactions between power and product attribute were significant [$F(1, 104) = 91.617$, $p < 0.001$]. Further results revealed that subjects' impulsiveness to purchase utilitarian music player was significantly higher (M = 4.07, SD = 0.83) than hedonic music player [M = 2.37, SD = 0.69, $F(1, 104) = 40.028$, $p < 0.001$] in the high-power condition. In the low-power condition, subjects' impulsiveness to purchase hedonic music player was significantly higher (M = 4.19, SD = 0.92) than utilitarian music player [M = 2.48, SD = 1.19, $F(1, 104) = 51.978$, $p < 0.001$]. The statistical diagram is shown in **Figure 2**.

Discussion

Study 1 shed light on the impact of the experience of power on impulsiveness to purchase products different attributes. The results demonstrated that subjects with high-power experience preferred utilitarian product more significantly compared with hedonic choice. On the contrary, subjects with low-power experience preferred the product with hedonic attribute rather than utilitarian product, which provided support for H1 and H2. Because powerful consumers have a stronger mentality of utility, individuals' intentions and behavior are more consistent with their values when they have greater power (Magee and Smith, 2013), and thus they

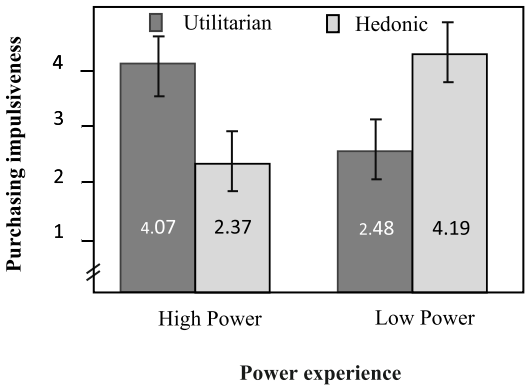

FIGURE 2
Results of study 1.

prefer products that could bring them functional value (Magee and Galinsky, 2008). Therefore, powerful consumers are more likely to be attracted by the utilitarian attribute, which leads to a higher impulsive purchase intention for these products. On the contrary, powerless consumers rely on emotions to make decisions (Jin and Zhu, 2016),they get immediate gratification by buying hedonic products.

Study 2: Robustness of the impact of the experience of power on purchase impulsiveness

In study 1, we manipulated subjects' power experience using the method of an episodic recall. In order to test the robustness of our findings in study 1, we conducted study 2 using an alternative measure of chronic power experience with a different stimulus material in a new context.

Pretest

In study 2, we chose a laptop as the stimulus material and manipulated it hedonic and utilitarian attributes according to the previous research (Chitturi et al., 2008). Subjects (under graduation students, $N = 23$) were randomly assigned to one of two groupings and read information about the different attributes of a laptop. The laptop was described as a combination of three utilitarian or three hedonic attributes respectively. The utilitarian dimension included the level of processing speed, memory size, and audio clarity. The hedonic dimension consisted of screen size, color, and weight. We combined these attribute descriptions with two pictures of the different laptops (see **Supplementary Appendix Table 1**). Then subjects evaluated each of three product attributes in different groupings with two seven-point items: "to what extent you think it is the utilitarian (hedonic) attribute of the laptop" (1 = strongly disagree, 7 = strongly agree). The attractiveness of the laptop was measured in the descriptions with a seven-point item (attractiveness: 1 = not attractive at all, 7 = very attractive). The results demonstrated that processing speed [$M_{hedonic} = 2.29$, $SD = 1.23$ vs. $M_{utilitarian} = 5.75$, $SD = 1.22$, $t\ (11) = 16.14$, $p < 0.001$], memory size [$M_{hedonic} = 2.67$, $SD = 0.96$ vs. $M_{utilitarian} = 5.82$, $SD = 1.09$, $t\ (11) = 15.71$, $p < 0.001$] as well as audio clarity [$M_{hedonic} = 3.28$, $SD = 1.25$ vs. $M_{utilitarian} = 5.05$, $SD = 0.94$, $t\ (11) = 7.46$, $p < 0.001$] were more utilitarian, and screen size [$M_{hedonic} = 5.08$, $SD = 0.77$ vs. $M_{utilitarian} = 3.97$, $SD = 1.28$, $t\ (10) = 4.21$, $p < 0.05$], color [$M_{hedonic} = 6.21$, $SD = 1.21$ vs. $M_{utilitarian} = 2.38$, $SD = 1.19$, $t\ (10) = 25.17$, $p < 0.001$] as well as weight [$M_{hedonic} = 5.35$, $SD = 1.47$ vs. $M_{utilitarian} = 3.47$, $SD = 1.27$, $t\ (10) = 6.42$, $p < 0.01$] were more hedonic, indicating a successful manipulation of product attribute. The results also showed that attractiveness had no difference between two groupings ($M_{hedonic} = 4.01$, $SD = 1.52$ vs. $M_{utilitarian} = 4.27$, $SD = 1.87$, *ns*).

Design and procedure

A total of 97 MBA students ($M_{age} = 31.02$, $SD = 4.65$, 60.82% females) in a university participated in the study for course credit. Subjects were randomly assigned to one of four conditions in a 2 (the experience of power: high vs. low) × 2 (product attribute: hedonic vs. utilitarian) between-subjects design. Different from study 1, subjects were asked to rate their agreement with eight items, e.g., "in my relationship with others, I think I have a great deal of power (1 = strongly disagree, 7 strongly agree)," to assess the power experience (see **Supplementary Appendix A**). As in previous research (Anderson and Galinsky, 2006), the scale showed high internal consistency ($\alpha = 0.96$). Then, subjects were exposed to the scenario:

> A few days ago, you got an annual bonus of ¥10,000. You want to buy a sport bicycle to take exercise at leisure time. At the end of this week, you go to the shopping mall with the money and a credit card to buy the bicycle (priced at ¥3,999) that you have followed with interests for some times. But when you walk through the mall, you find a new laptop (priced at ¥8,899) is selling fantastically. You like it very much.

Besides, descriptions for utilitarian or hedonic attributes of the laptop in different design groupings were same to the pretest study. And then the subjects were asked to answer: (1) buying the bicycle only, (2) wanting the laptop but not buying it, (3) deciding not to buy the bicycle, (4) buying both the bicycle and the laptop with the credit card, and (5) buying these plus a matching laptop bag with the credit card.

Results

Chronic power experience

We took the average scores of eight items of chronic level of power, ranking the average scores from high to low, and then carried out a median split. The results demonstrated that powerful subjects rated significantly higher scores ($M = 5.27$, $SD = 0.78$) than powerless ones [$M = 2.77$, $SD = 0.61$, $F(1, 95) = 306.54$, $p < 0.001$].

Manipulation check

Likewise, the results of manipulation check for product attribute priming were almost identical to that in pretest study.

Purchase impulsiveness

The ANOVA analysis showed that the main effect of chronic level of power on purchase impulsiveness was not significant [$F(1, 93) = 2.075$, $p = 0.153$]. The main effect of product attribute on purchase impulsiveness was also not significant [$F(1, 93) = 0.017$, $p = 0.896$]. But the interactions between power experience and product attribute were significant [$F(1, 93) = 42.193$, $p < 0.001$]. Specifically, subjects with high-power experience showed higher impulsiveness to purchase utilitarian laptop ($M = 4.29$, $SD = 1.23$) than hedonic laptop [$M = 2.84$, $SD = 1.02$, $F(1, 93) = 15.193$, $p < 0.001$]. Subjects with low-power experience had higher impulsiveness to purchase hedonic laptop ($M = 4.21$, $SD = 1.18$) than utilitarian laptop [$M = 2.58$, $SD = 1.25$, $F(1, 93) = 27.171$, $p < 0.001$]. See **Figure 3** for detailed results.

Discussion

We replicated the findings in study 1 by measuring subject's chronic level of power in a different consumption condition. As predicted, study 2 also provided the evidence that the impact of power experience on consumer impulsiveness to purchase products

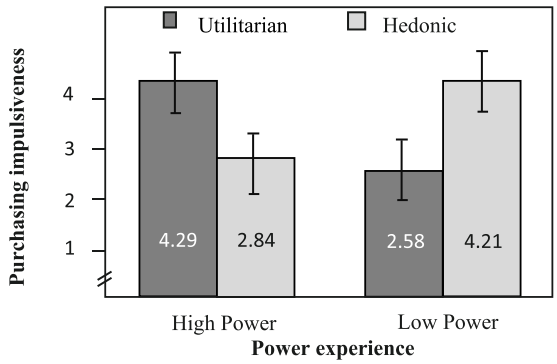

FIGURE 3
Results of study 2.

with utilitarian or hedonic attributes was robust. As expected, consumers with high chronic power experience were more likely to impulsively buy utilitarian products, whereas those with low-power experience were more likely to be fond of hedonic products. Taken together, studies 1 and 2 provided converging evidences for the hypothesized effect of power experience on relative preference for utilitarian versus hedonic products, and study 2 further verified the findings in the condition of chronic power experience. However, besides the power experience, consumers would also have power expectations. Different from the effect of power experience, power expectation perhaps has a completely different effect on impulsiveness to purchase utilitarian or hedonic products. In the next study, we demonstrated that whether power expectation would moderate the relationships between the power experience and impulsiveness to purchase utilitarian or hedonic products.

Study 3: The moderate effect of the expectations of power

The purpose of study 3 was to test the moderating effect of the expectations of power on the impact of power experience on impulsiveness to purchase utilitarian or hedonic products.

Pretest

This pretest was conducted to examine the manipulation of the expectations of power according to the existing study (Rucker et al., 2014). Subjects (under graduation students, $N = 54$) were randomly assigned into one of two conditions, in which they were asked about their expectations for either high or low power regarding individual's hedonic consumption. Subjects rated their agreement with the statements that individuals with high or low power would "own possessions associated with hedonic products" (1 = strongly disagree, 7 = strongly agree), "buy hedonic products" (1 = strongly disagree, 7 = strongly agree). We add up the scores of the two items ($\alpha = 0.89$) and then average them, and the results of the ANOVA verified that subjects expected powerful people to be more likely to possess or buy hedonic products ($M = 5.11$, $SD = 0.96$) than the powerless ones [$M = 2.91$, $SD = 0.71$, $F(1, 52) = 91.680$, $p < 0.001$].

Next, in this study we chose trainers as the stimulus material and manipulated their utilitarian and hedonic attributes according to the previous research (Crowley et al., 1992). Subjects (under graduation students, $N = 42$) were randomly assigned to one of two groupings. The trainers were described as a combination of the two utilitarian aspects (wear resistance and protection) or two hedonic aspects (color and style). In the utilitarian grouping, the trainers were described as follows:

> There is a pair of very practical trainers. The trainers are very durable so that they don't fear wear and tear anywhere and anytime. At the same time, the sole has high-tech protective air cushion, which keeps your ankle away from hurt when you take exercises.

In the hedonic grouping, the trainers were described as follows:

> There is a pair of very fashionable trainers with red, white, black, green, orange, and blue colors for you to choose. Besides, the trainers are also a "style king" so that you will feel free and casual, and they could highlight your charm and fashion when wearing them.

Then subjects evaluated each of two product attributes in different groupings with a seven-point item: "to what extent you think it is the utilitarian (hedonic) attribute of the trainers" (1 = utilitarian, 7 = hedonic). The attractiveness of the trainers was measured with a seven-point item (attractiveness: 1 = not attractive at all, 7 = very attractive). The results demonstrated that wear resistance [$M_{hedonic} = 2.95$, $SD = 0.86$ vs. $M_{utilitarian} = 5.76$, $SD = 0.77$, $F(1, 40) = 123.879$, $p < 0.001$] as well as protection [$M_{hedonic} = 2.52$, $SD = 0.80$ vs. $M_{utilitarian} = 5.38$, $SD = 0.80$, $F(1, 40) = 121.622$, $p < 0.001$] were more utilitarian, and color [$M_{hedonic} = 5.24$, $SD = 0.62$ vs. $M_{utilitarian} = 2.67$, $SD = 0.73$, $F(1, 40) = 150.309$, $p < 0.001$] as well as style [$M_{hedonic} = 5.38$, $SD = 0.80$ vs. $M_{utilitarian} = 2.86$, $SD = 0.85$, $F(1, 40) = 97.197$, $p < 0.001$] were more hedonic, indicating a successful manipulation of product attributes. The results also showed that attractiveness had no difference between two groupings [$M_{hedonic} = 5.38$, $SD = 0.80$ vs. $M_{utilitarian} = 5.14$, $SD = 0.65$, $F(1, 40) = 1.106$, $p = 0.299$].

Design and procedure

A total of 165 undergraduate students ($M_{age} = 20.82$, $SD = 1.09$, 61.21% females) in a university participated in the study for course credit. Subjects were randomly assigned to one of eight conditions in a 2 (the experience of power: high vs. low) × 2 (the expectations of power: yes vs. no) × 2 (product attribute: hedonic vs. utilitarian) between-subjects design.

Firstly, prior to presenting what happened in the scenario, subjects were first asked to "write down your relationship with the person who you had power over (who had power over you)," and then asked to describe "what happened during the event referring to that person and how you felt during the event referring to that person" (Rucker et al., 2014). Then, subjects completed the same manipulations in study 1 and were asked "how powerful did you feel when completing the recall task" (1 = not powerful at all, 7 = very powerful). They also were asked to rate "to what extent you engaged in the scenario role task?" (1 = not at all engaged, 7 = very

much engaged). The mood was also measured, and results didn't show different positive affect [$F(1, 163) = 0.38$, $p < 0.539$, *ns*] or negative affect [$F(1, 163) = 1.071$, $p < 0.302$, *ns*] in different power contexts.

Subsequently, we adopted the episodic priming method used in prior research (Rucker et al., 2014) to manipulate the expectations of power. Subjects were first asked to "write down the name or title of the role you held" and they were then asked to "describe what other people generally expect from someone in this role or similar roles and the stereotypes associated with this role." In the condition with power expectation priming, we measured the subjects' power experience and expectation by asking two questions: "how powerful did you feel when completing the recall task?" (1 = not powerful at all, 7 = very powerful) and "to what extent you anticipated the behavior of the role you held in the situation?" (1 = not at all anticipated, 7 = very much anticipated). The subjects in the condition without power expectation priming needed to do an irrelevant task, i.e., "imagine the place where you want to travel in the future." Then, subjects were exposed to the scenario:

> A few days ago, you just got a part-time job salary of ¥500 which you could control freely. Now, you need to buy a calculator needed in your mathematics course. At the end of this week, you go to the shopping mall with the money and a credit card to buy the calculator (priced at about ¥100). But when you walk through the shopping mall, you find a pair of trainers (priced at ¥489) is selling fantastically. You like them very much.

Besides, manipulations for utilitarian or hedonic attributes of the trainers were same to the pretest. And then the subjects were asked to answer: (1) buying the calculator only, (2) wanting the trainers but not buying it, (3) deciding not to buy the calculator, (4) buying both the calculator and the trainers with the credit card, and (5) buying these plus a matching T-shirt with the credit card.

Results

Manipulation check

As expected, subjects in the high-power condition reported that their feelings were significantly more powerful ($M = 4.94$, $SD = 1.02$) than those in the low-power condition [$M = 3.14$, $SD = 1.21$, $F(1, 163) = 107.20$, $p < 0.001$]. In addition, subjects reported a higher level of power experience involvement ($M = 6.08$, $SD = 0.80$), indicating a successful manipulation of power experience. The examination of power expectation showed that the subjects with high- or low-power experience had significant differences in the sense of power after the manipulation of power expectations [$F(1, 82) = 116.983$, $p < 0.001$]. When power expectation was activated, subjects in the high-power condition felt more powerful ($M = 5.33$, $SD = 0.82$) compared with those in the low-power condition ($M = 3.29$, $SD = 0.90$). The subjects reported a higher degree of power expectation involvement ($M = 6.11$, $SD = 0.77$). In addition, with regard to powerful people, there was no significant difference in the score of sense of power between the two groups that activated the expectations of power ($M = 5.14$, $SD = 0.98$) and did not activate the expectations of power [$M = 4.74$, $SD = 1.04$, $F(1, 82) = 3.388$, $p = 0.069$]; for people with a low sense of power, there was no significant difference in scores between the group with power expectation ($M = 3.02$, $SD = 1.19$) and the group without power expectation [$M = 3.25$, $SD = 1.24$, $F(1, 79) = 0.699$, $p = 0.406$]. Similarly, the results of manipulation check for product attribute priming were almost identical to the pretest study, indicating a successful manipulation of product attributes.

Purchase impulsiveness

The results of ANOVA analysis showed that the main effect of power experience on purchase impulsiveness was significant [$F(1, 163) = 9.559$, $p < 0.01$]. The main effect of product attribute on purchase impulsiveness was not significant [$F(1, 163) = 2.250$, $p = 0.136$]. The main effect of power expectation on purchase impulsiveness was also not significant [$F(1, 163) = 0.436$, $p = 0.510$]. The interactive effects of power expectation, power experience and product attribute on purchase impulsiveness were significant [$F(1, 163) = 5.113$, $p < 0.05$].

Specifically, after priming the power expectation, the main effect of power experience on purchase impulsiveness was significant [$F(1, 79) = 53.773$, $p < 0.001$]. The main effect of product attribute on purchase impulsiveness was not significant [$F(1, 79) = 1.962$, $p = 0.165$]. The interactions between power experience and product attribute on purchase impulsiveness were significant [$F(1, 79) = 4.031$, $p < 0.05$]. In terms of the subjects with high-power experience, there was a significant difference in purchase impulsiveness between utilitarian and hedonic trainers [$F(1, 79) = 5.881$, $p < 0.05$]; for the subjects with low-power experience, there was no significant difference in purchase impulsiveness between utilitarian and hedonic trainers [$F(1, 79) = 0.182$, $p = 0.671$].

When there was no power expectation priming, the main effect of power experience on purchase impulsiveness was not significant [$F(1, 78) = 3.628$, $p = 0.061$]. The main effect of product attribute on purchase impulsiveness was also not significant [$F(1,78) = 1.905$, $p = 0.171$]. The interactions between power experience and product attribute had a significant effect on purchase impulsiveness [$F(1, 78) = 51.246$, $p < 0.001$]. In terms of the subjects with high-power experience, there was a significant difference in purchase impulsiveness between utilitarian and hedonic trainers [$F(1, 78) = 17.112$, $p < 0.001$]; for the subjects with low-power experience, there was also a significant difference in purchase impulsiveness between utilitarian and hedonic trainers [$F(1, 78) = 35.589$, $p < 0.001$]. The results of the comparisons are shown in **Table 1**.

Discussion

In study 3, we utilized an imagined role task to examine the impact of power experience on the impulsiveness to purchase utilitarian and hedonic products. More important, the study 3 extended the former two studies in the condition considering the moderate effect of power expectation. As presumed in H3 and H4, it was found that when power expectation was stimulated, consumers with low-power experience reduced impulsiveness to purchase hedonic products. Consumers with high-power experience increased impulsiveness to purchase hedonic products, but their impulsiveness to purchase utilitarian goods were not affected. In study 4, we extended our findings by verifying that when power expectation was activated, deservingness was an underlying

TABLE 1 Comparisons of purchase impulsiveness when the power expectation was activated or not.

Product attribute	High-power experience		Low-power experience	
	Power expectation		Power expectation	
	Yes	No	Yes	No
Utilitarian	4.48 (0.93)	4.62 (1.07)	3.29 (1.06)	3.45 (0.94)
Hedonic	5.24 (1.09)	3.33 (1.11)	3.15 (0.99)	5.35 (0.88)

SDs are presented in the parentheses.

mediation reason for the impact of power experience on the impulsiveness to purchase utilitarian or hedonic products.

Study 4: The mediate effect of deservingness

The main objective of study 4 was to test H5 and H6. Specifically, when power expectation was activated, we expected that consumers with low-power experience would have lower perception of deservingness, whereas consumers with high-power experience would have higher perception of deservingness. Deservingness would play a role in mediating the impact of power experience on impulsiveness to purchase utilitarian or hedonic products.

Pretest

We manipulated situational power experience and power expectation through a task involving imagined roles. Subjects (under graduation students, N = 44) were told to imagine themselves either as a boss or an employee in a firm while reading a scenario describing that role (Rucker et al., 2014). Subjects in the high-power context read:

> As a boss, you are responsible for directing your employees in making products. You have the right to decide the procedure of making products and the rules by which you appraise your subordinates. You evaluate your employees' work performance quarterly but don't give feedback of the final evaluation results to your employees. The employees have no rights to appraise your work.

In contrast, subjects in the low-power context read:

> As an employee, you are in charging of making products according to your boss's instructions. The boss determines the rules by which your work performance is to be appraised. As the employee, you must follow the orders of the boss. You will be appraised by the boss quarterly, and this evaluation results will not be given to you. You have no rights to appraise the boss.

After reading the scenario, subjects were asked to write about the role they were assigned, and answered "what the boss (employee) would think and how they would feel." In addition, the subjects were asked to answer two questions: "how powerful did you feel with the role that you read?" (1 = not powerful at all, 7 = very powerful) and "to what extent you concentrated on the role that you read?" (1 = not at all concentrated, 7 = very much concentrated). Results demonstrated that subjects in the high-power condition showed significantly more powerful (M = 5.14, SD = 1.32) than those in the low-power condition [M = 2.91, SD = 0.97, $F(1, 42) = 40.629$, $p < 0.001$]. Meanwhile, subjects reported a higher involvement of power experience (M = 6.14, SD = 0.63).

In the power expectation priming task, subjects (N = 46) were asked to write about "what other people generally expect from someone in this role (boss or employee)." The power experience and the involvement degree of power expectation were measured in two seven-point items: "how powerful did you feel with the role that you read?" (1 = not powerful at all, 7 = very powerful) and "to what extent you anticipated the behavior of the role you held in the situation?" (1 = not at all anticipated, 7 = very much anticipated). The results showed that subjects in high-power expectation condition reported more powerful (M = 5.13, SD = 1.29) than those in low-power expectation condition [M = 2.78, SD = 0.95, $F(1, 44) = 49.348$, $p < 0.001$]. The subjects also reported a higher involvement degree of power expectation (M = 6.17, SD = 0.64).

In the pretest, we chose a smart wrist watch as the stimulus material and manipulated its utilitarian or hedonic attributes based on the previous research (Jin and Zhu, 2016). Subjects (under graduation students, N = 51) were randomly assigned to one of two groupings. In the utilitarian or hedonic groupings, subjects were exposed to a picture of a smart wrist watch with descriptions about its attributes in details respectively (see **Supplementary Appendix Table 2**). Then subjects evaluated the production attributes and attractiveness according to the descriptions with two seven-point items (attributes: 1 = hedonic, 7 = utilitarian; attractiveness: 1 = not attractive at all, 7 = very attractive). The results showed that the manipulation of product attributes was successful [M_{hedonic} = 3.19, SD = 1.13 vs. $M_{\text{utilitarian}}$ = 4.64, SD = 1.29, $F(1, 49) = 18.230$, $p < 0.001$], and attractiveness had no difference between two groupings [M_{hedonic} = 5.27, SD = 0.72 vs. $M_{\text{utilitarian}}$ = 5.08, SD = 0.70, $F(1, 49) = 0.896$, $p = 0.348$].

Design and procedure

A total of 252 undergraduate students (M_{age} = 20.71, SD = 1.10, 67.06% females) in a university participated in the study for course credit. Subjects were randomly assigned to one of eight conditions in a 2 (the experience of power: high vs. low) × 2 (the expectations of power: yes vs. no) × 2 (product attribute: hedonic vs. utilitarian) between-subjects design.

Firstly, we manipulated the experience of power with the same method used in the pretest study. Similarly, subjects also didn't feel different positive affect [$F(1, 250) = 0.275$, $p = 0.600$, *ns*] or negative affect [$F(1, 250) = 0.475$, $p = 0.491$, *ns*] in different power contexts.

Subsequently, we adopted the same method used in the pretest study to manipulate power expectation. For people with a high

sense of power, there was no significant difference in the score of their power when activating the expectations of power (M = 4.79, SD = 1.09) compared with not activating it [M = 5.00, SD = 1.06, F(1, 124) = 1.152, p = 0.285]; for people with a low sense of power, there was no significant difference in the score of their power when activating the expectations of power (M = 3.10, SD = 1.069) compared with not activating it [M = 3.21, SD = 1.08, F(1, 124) = 0.340, p = 0.561]. The subjects in the condition with power expectation priming reported a higher involvement degree of power expectation (M = 5.25, SD = 0.82). Subjects in the condition without power expectation priming were asked to do an irrelevant task, i.e., "imagine the place where you want to travel in the future." Then, subjects were exposed to the scenario:

> You need to buy a laptop used for your home job. On Sunday, you go to the shopping mall with ¥6000 and a credit card to buy a laptop (priced at ¥5589) that you have followed with interests for some times. But when you walk through the mall, you find a smart wrist watch (priced at ¥1899) is selling fantastically. You like it very much.

Besides, the manipulation of utilitarian and hedonic attributes of the watch in different design groupings was same to the pretest study. Purchase impulsiveness were measured through the questions: "would you likely buy this smart wrist watch?" (1- exactly not, 7- definitely yes).

Subsequently, to assess the deservingness, subjects rated with four seven-point items: "after reading the scenario, to what extent did you feel you deserve to" (1) "...reward yourself," (2) ".treat.. yourself to nice things," (3) ".indulge yourself a little," and (4) ".buy something special for yourself." (1 = "not at all deserving" and 7 = "extremely deserving") (Cavanaugh, 2014). Items were combined into one deservingness measure (α = 0.96). To assess the purchase impulsiveness, we used the same method employed in study 1.

Results

Manipulation check

Subjects in the high-power experience condition reported feeling significantly more powerful (M = 4.90, SD = 1.08) than those in the low-power experience condition [M = 3.15, SD = 1.07, F(1, 250) = 166.841, p < 0.001], indicating a successful manipulation of power experience. Likewise, the results of manipulation check for product attribute priming were identical to the pretest, indicating a successful manipulation of product attributes. The reliability coefficient of deservingness was 0.91.

Purchase impulsiveness

The results of ANOVA analysis showed that the main effect of power experience on purchase impulsiveness was significant [F(1, 244) = 15.801, p < 0.001]. The main effect of product attribute on purchase impulsiveness was not significant [F(1, 244) = 0.337, p = 0.562]. The main effect of power expectation on purchase impulsiveness was not significant [F(1, 244) = 2.844, p = 0.093]. The interactive effects of power experience, power expectation and product attribute on purchase impulsiveness were significant [F(1, 244) = 36.098, p < 0.001].

When the subjects were activated to have the expectations of power, the main effect of power experience on purchase impulsiveness was significant [F(1, 122) = 54.186, p < 0.001]. The main effect of product attribute on purchase impulsiveness was not significant [F(1, 122) = 0.014, p = 0.907]. The interactions between power experience and product attribute had a significant effect on purchase impulsiveness [F(1, 122) = 4.541, p = 0.035]. In terms of subjects with high-power experience, there was not significant difference in purchase impulsiveness between utilitarian and hedonic watches [F(1, 122) = 2.526, p = 0.115], there was no significant difference in purchase impulsiveness between utilitarian and hedonic watches for subjects with low-power experience [F(1, 122) = 2.028, p = 0.157].

When the power expectation was not activated, the main effect of power experience on purchase impulsiveness was not significant [F(1, 122) = 1.281, p = 0.260]. The main effect of product attribute on purchase impulsiveness was also not significant [F(1, 122) = 0.445, p = 0.506]. The interactions between power experience and product attribute had a significant effect on purchase impulsiveness [F(1, 122) = 37.312, p < 0.001]. In terms of subjects with high-power experience, there was a significant difference in purchase impulsiveness between utilitarian and hedonic watches [F(1, 122) = 14.802, p < 0.001]. For subjects with low-power experience, there was also a significant difference in purchase impulsiveness between utilitarian and hedonic watches [F(1, 122) = 22.956, p < 0.001]. The results of the mean comparisons are listed in **Table 2**.

The main effect of the impact of power experience on deservingness was significant [F(1, 244) = 26.629, p < 0.001]. The main effect of product attribute on deservingness was not significant [F(1, 244) = 0.539, p = 0.464]. The main effect of power expectation on deservingness was also significant [F(1, 244) = 5.794 p = 0.017]. The interactions between power experience, power expectation and product attribute had a significant impact on the deservingness [F(1, 244) = 38.550, p < 0.001]. The results of the comparisons of deservingness in different groupings are shown in **Table 3**.

Mediation analysis

To examine the mediate effect of deservingness, we conducted a bootstrapping analysis (model 8). With the power expectation as a moderator and deservingness as a mediator, we carried out the regression analysis (the sample size = 5000, CI = 95%) in which interactions between power experience and product attribute were an independent variable and purchase impulsiveness was used as a dependent variable. Conditional indirect effect results showed that the interaction effects of experience of power, product type and the expectations of power on deservingness is significant, β = −1.436, SE = 0.261, CI (−1.9492, −0.9220). Deservingness has a significant effect on purchase impulsiveness, β = −0.449, SE = 0.067, CI (0.3161, 0.5816), deservingness mediated the interactions between the experience of power, product attribute and the expectations of power on purchase impulsiveness, β = −0.644, SE = 0.167, CI (−1.0231, −0.3643). Hence, H5 and H6 were supported. The result of mediation test is shown in **Figure 4**.

Discussion

The convergent support for H3 and H4 in study 4 using different operationalizations of power and different measures of purchase impulsiveness is reassuring. Furthermore, we found evidence that the mechanism underlying this effect was a sense

TABLE 2 Comparisons of purchase impulsiveness when the power expectation was activated or not.

Product attribute	High-power experience		Low-power experience	
	Power expectation		Power expectation	
	Yes	No	Yes	No
Utilitarian	4.63 (0.91)	4.84 (1.32)	3.68 (1.05)	3.81 (1.05)
Hedonic	5.03 (1.11)	3.71 (1.35)	3.31 (0.99)	5.22 (0.91)

SDs are presented in the parentheses.

TABLE 3 Results of comparisons of deservingness in different groupings.

Product attribute	High-power experience		Low-power experience	
	Power expectation		Power expectation	
	Yes	No	Yes	No
Utilitarian	4.45 (0.70)	4.84 (1.32)	3.46 (0.78)	3.77 (1.33)
Hedonic	4.90 (0.91)	3.70 (0.90)	3.15 (0.89)	4.93 (0.85)

SDs are presented in the parentheses.

of deservingness. Specifically, deservingness mediated the effect of power experience on impulsiveness to purchase utilitarian and hedonic products when power expectation is activated. That is because consumers with low-power experience could not find the reasons to impulsively buy hedonic products when they image their consumption behavior through the schema and scripts of powerless people's behavior. Social stereotypes generally posit that powerless people have less valuable resources and they should spent on necessary utilitarian products (Magee and Galinsky, 2008). Therefore, powerless people get a low sense of deservingness, and have no way to justify that they are qualified to consume hedonic products. Deservingness is a self-conscious emotion related to the evaluation of self-worth and capability, which can provide a reasonable reason for hedonic consumption (Cavanaugh, 2014). In contrast, social stereotypes generally believe that people with high-power are more qualified to have fun (Magee and Galinsky, 2008), the expectations of powerful people's consumption to stimulate the hedonic motivation of people with high sense of power, and they can find the justification of "I deserve" for hedonistic impulsive buying.

General discussion

A large number of studies have recently examined the impacts of power on various aspects of consumer behavior and decision-making (e.g., Rucker et al., 2012; Mourali and Yang, 2013; Duan et al., 2017; Li et al., 2022). This manuscript introduced a new theoretical perspective for understanding the effects of power in impulsive buying. Collectively, four studies support our theorizing regarding the interplay of the experience of power and the expectations of power on purchasing impulsiveness for different products. The results in studies 1 and 2 demonstrated that when focused on the psychological experience of power, consumers with either situational or chronic low-power experience would have higher impulsiveness to purchase hedonic products; whereas consumers with primed either situational or chronic high-power experience would have higher impulsiveness to purchase utilitarian products. However, study 3 showed that when focused on the expectations of power, powerless people would significantly reduce their impulsiveness to purchase hedonic products, and in terms of consumers with high-power, their impulsiveness to purchase hedonic products would increase significantly. Further, study 4 uncovered the mechanism underlying this phenomenon is that the expectations of power will induce consumers to think about how people with different power should do in consumption (Rucker et al., 2014), which in turn will lead consumers to evaluate the normalization of their consumption behavior (Rook and Fisher, 1995). The powerless consumers cannot justify the normative causes to purchase hedonic products because they don't think they deserve them. On the contrary, powerful consumers will amplify the sense of "deservingness," which leads to a significant increase in their impulsiveness to purchase hedonic products. Therefore, our findings verified that deservingness mediated the impact of power experience on impulsiveness to purchase products with different attributes when power expectation was activated.

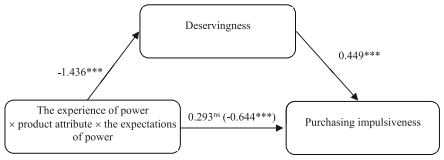

FIGURE 4
The mediate role of deservingness when the expectations of power were activated. ***$p < 0.001$.

Theoretical contributions

We believe this research makes several contributions. Firstly, for the literature on impulsive buying, this work demonstrates a relatively novel effect: the moderating impact of the expectations of power on purchase impulsiveness. Previous studies have mainly focused on the impact of the experience of power on impulse purchase, and have not yet reached a consistent conclusion. For example, the power-approach theory has found that power activates a general tendency to approach whereas powerlessness activates a general tendency to inhibit. As a result, power was associated with an increased tendency to impulsive buying (Keltner et al., 2003).

On the contrary, research based on the "construct level theory" has found that powerful people tend to make decisions at a high level of construction, and pay more attention to the long-term results of decisions, which enable them to avoid short-sighted behavior and are not easy to impulsively purchase products; while powerless people will show an adverse inclination (Smith and Trope, 2006). Hence, powerful consumers are more likely to be impulsive in consumption, while powerless ones are less likely to be impulsive. However, power is accompanied by both an experience and expectations, the link between power and behavior can critically depend upon whether an individual focuses on the experience or expectations of power (Rucker et al., 2014). Given these conflicting effects of power and impulsive buying, we first delineate a two-facet portrait of power in the role of affecting purchase impulsiveness by proposing a theoretical extension from the experience of power to the expectations of power. When focused on the experience of power, people concern about how an experience of power makes them feel and how they should respond based on those feelings (Rucker et al., 2014), thus, powerless individuals are more likely to buy hedonic products on impulse to get a positive experience of immediate gratification. In contrast, powerful individuals pay less attention to the symbolism of the product, but more to the functional value of the product (Magee and Galinsky, 2008), they are more likely to have impulsive desire for utilitarian products (Jin and Zhu, 2016). While the activation of schemas or scripts related to power produce a very differential outcome as is produced were one to focus on the internal experience of power. People activating the expectations of power focus on the cause of the impulsive buying, powerless people could not find out the cause to purchase hedonic products, because when focused on the actual cause of their impulse, they found themselves unable to indulge hedonic products. On the other hand, powerful people have the ability to engage in the consumption of hedonic products.

Secondly, the study further shed lights on the effect of consumers' self-awareness emotions by identifying the mediation role of deservingness in the impact of three-way interactions between the experience of power, product attribute and the expectations of power on purchase impulsiveness. In this context, powerless consumers would experience lower sense of deservingness and could not prove their qualification and capability of "worth" indulging in consumption, because social stereotypes argue that powerless people have less valuable resources and thus should be simple and frugal (Magee and Galinsky, 2008). On the contrary, powerful people have more valuable resources, more ability and enjoyment (Rucker et al., 2014). In this scene, powerful consumers would spontaneously generate higher sense of deservingness, and produce a higher impulsiveness to purchase hedonic products. Deservingness is often discussed in marketing advertising, which has been proved to affect consumers' purchase intentions. Although extant research has examined deservingness playing an important role in consumer decision-making (Cavanaugh, 2014), few research has systematically explored the role of deservingness on impulsive purchase behavior. Our research confirmed that consumers' focus on either the psychological experience of power or the expectations of power can influence normative evaluations of impulsiveness to purchase utilitarian or hedonic products through the sense of deservingness. The conclusions would enrich and supplement the literature on the relationships between deservingness and impulsive purchase behavior.

A final contribution of this research is that it offers not only a new theoretical lens of power on purchasing impulsiveness, but suggests a tool of self-regulation. Prior studies show that highly impulsive buyers do not give in to every spontaneous buying demand, they will make the judgments about the appropriateness of making an impulsive purchase (Rook and Fisher, 1995), in fact, consumers' impulse buying behavior is the result of the failure of self-control (Baumeister, 2002). We tested that one likely intervening factor arises from the expectations of power. When the expectations of power are activated, it is likely to elicit the normative evaluations about the appropriateness of making an impulsive purchase of hedonic products. In other words, the expectation of power act as a self-control mechanism for impulse purchase.

Managerial implications

The findings also raise some practical suggestions for firms that want to stimulate consumer impulsive purchase behavior. First, marketers need to design marketing plan accurately according to product attributes and target consumers' characteristics of power. Specifically, powerless consumers are more likely to buy hedonic products impulsively; whereas powerful consumers are more likely to impulsively purchase utilitarian products. Meanwhile, besides the chronic characteristics, the power perception may also be influenced by situational factors and consumers perhaps have the temporary power perception. For example, a boss who has an authority in a firm may also experience a temporary low power because of the unsuccessful contract negotiations. These findings suggest that in addition to observing the consumers' chronic characteristics of power, a variety of measures such as background music, placement of products or sales person's language can be taken to stimulate the consumer's temporary power perception (Luo et al., 2016; Huang et al., 2017).

Moreover, firms need to conscientiously manage consumers' power expectation. The power expectation refers to the social stereotypes that how and what consumers with different power should do in the opinions of other individuals, which can lead to consumers' evaluation of consumption rationality. Hence, firms should take various ways to activate the power expectation for consumers with high power perception. Contrarily, firms should try to avoid the power expectation for consumers with low power perception, and guide them to focus on the positive experience of consumption or shorten their decision time.

Finally, marketers need to realize that the sense of deservingness is actually a double-edged sword. For powerful consumers, reminding of deservingness may enhance their impulsive purchase intention. But in terms of powerless consumers, deservingness perhaps reduces consumers' impulsive purchase intention because they cannot find reasons for rationalization of consumption.

Limitations and future research

This research also has some limitations that should be discussed in future research. Firstly, we demonstrated that power experience and power expectation can affect consumers' impulsiveness to

purchase utilitarian and hedonic products. The present research also confirmed that whether or not consumers having the sense of power expectation were one of the key influential factors of purchase impulsiveness. However, the question that what factors will be the antecedents of power expectation has not been discussed. For example, Rucker et al. (2014) assumed that interdependent self-construal individuals might be prone to consider the power expectation, and independent self-construal individuals might be more likely to focus on the power experience as they concentrate more on the self in comparison. Therefore, it is necessary to study the boundary conditions and moderators of the relationships between power expectation and purchase impulsiveness in future research.

Secondly, we verified that when the expectations of power were primed, the sense of deservingness would play a mediation role in the impact of interactions between power experience and product attribute on purchase impulsiveness. Deservingness is related to consumers' positive psychological emotions (Xu and Schwarz, 2009). However, the impact of the expectations of power on consumers' negative emotions, such as guilt, has not yet been studied. Guilt is a self-conscious emotion with negative valence, which can influence consumers' self-control (Giroux et al., 2022). In future research, it is valuable to continue exploring the impact of the expectations of power on purchase impulsiveness with guilt as a mediator.

Finally, with the measurement method of deservingness, it was found that when the expectations of power were activated, powerless consumers had lower sense of deservingness, which in return would reduce consumers' impulsiveness to buy hedonic products. In future research, we will manipulate powerless people's sense of deservingness in order to observe their impulsiveness to purchase the hedonic products. We speculate that, when increasing the deservingness, even if power expectation were primed, powerless people would not reduce their impulsiveness to purchase the hedonic products inasmuch as they could enjoy their feeling of deservingness.

Data availability statement

The original contributions presented in this study are included in the article/**Supplementary material**, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

Funding

This research was funded by the Research Project of Philosophy and Social Sciences of Tianjin (grant no. TJGL21-006).

Acknowledgments

We express sincere thanks to the reviewers for their constructive suggestions.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1094536/full#supplementary-material

References

Amos, C., Holmes, G. R., and Keneson, W. C. (2014). A meta-analysis of consumer impulse buying. *J. Retailing Consum. Serv.* 21, 86–97. doi: 10.1016/j.jretconser.2013.11.004

Anderson, C., and Galinsky, A. D. (2006). Power, optimism, and risk-taking. *Eur. J. Soc. Psychol.* 36, 511–536. doi: 10.10021/ejsp.324

Baumeister, R. F. (2002). Yielding to temptation: Self-control failure, impulsive purchasing, and consumer behavior. *J. Consum. Res.* 28, 670–676. doi: 10.1086/338209

Baumeister, R. F., Bratslavsky, E., Muraven, M., and Tice, D. M. (1998). Ego depletion: Is the active self a limited resource? *J. Pers. Soc. Psychol.* 74, 1252–1265. doi: 10.1037/0022-3514.74.5.1252

Berdahl, J. L., and Martorana, P. (2006). Effects of power on emotion and expression during a controversial group discussion. *Eur. J. Soc. Psychol.* 36, 497–509. doi: 10.1002/ejsp.354

Cavanaugh, L. A. (2014). Because i (don't) deserve it: How relationship reminders and deservingness influence consumer indulgence. *J. Mark. Res.* 51, 218–232. doi: 10.1509/jmr.12.0133

Chen, C. D., and Ku, E. C. S. (2021). Diversified online review websites as accelerators for online impulsive buying: The moderating effect of price dispersion. *J. Internet Commer.* 20, 113–135. doi: 10.1080/15332861.2020.1868227

Chen, C. Y., Lee, L., and Yap, A. J. (2017). Control deprivation motivates acquisition of utilitarian products. *J. Consum. Res.* 43, 1031–1047.

Chen, J., Chen, J. E., Goh, K. Y., Xu, Y. C., and Tan, B. C. (2014). When do sellers bifurcate from electronic multisided platforms? The effects of customer demand, competitive intensity, and service differentiation. *Inf. Manag.* 51, 972–983.

Chen, J. E., Pan, S. L., and Ouyang, T. H. (2014). Routine reconfiguration in traditional companies' e-commerce strategy implementation: A trajectory perspective. *Inf. Manag.* 51, 270–282. doi: 10.1016/j.im.2013.11.008

Chen, O., Zhao, X., Ding, D., Zhang, Y., Zhou, H., and Liu, R. (2022). Borderline pathological celebrity worship and impulsive buying intent: Mediating and moderating roles of empathy and gender. *Front. Psychol.* 13:823478. doi: 10.3389/fpsyg.2022.823478

Chitturi, R., Raghunathan, R., and Mahajan, V. (2007). Form versus function: How the intensities of specific emotions evoked in functional versus hedonic trade-offs mediate product preferences. *J. Mark. Res.* 44, 702–714. doi: 10.1509/jmkr.44.4.702

Chitturi, R., Raghunathan, R., and Mahajan, V. (2008). Delight by design: The role of hedonic versus utilitarian benefits. *J. Mark.* 72, 48–63.

Crowley, A. E., Spangenberg, E. R., and Hughes, K. R. (1992). Measuring the hedonic and utilitarian dimensions of attitudes toward product categories. *Mark. Lett.* 3, 239–249. doi: 10.1007/BF00994132

Dhar, R., and Wertenbroch, K. (2012). Self-signaling and the costs and benefits of temptation in consumer choice. *J. Mark. Res.* 49, 15–25. doi: 10.1509/jmr.10.0490

Duan, J., Wu, S. J., and Sun, L. (2017). Do the powerful discount the future less? The effects of power on temporal discounting. *Front. Psychol.* 8:1007. doi: 10.3389/fpsyg.2017.01007

Dubois, D., Rucker, D. D., and Galinsky, A. D. (2012). Supersize me: Product size as a signal of status. *J. Consum. Res.* 38, 1047–1062.

Galinsky, A. D., Gruenfeld, D. H., and Magee, J. C. (2003). From power to action. *J. Pers. Soc. Psychol.* 85, 453–466.

Garbinsky, E. N., Klesse, A. K., and Aaker, J. (2014). Money in the bank: Feeling powerful increases saving. *J. Consum. Res.* 41, 610–623. doi: 10.1086/676965

Giroux, M., Kim, J., Lee, J. C., and Park, J. (2022). Artificial intelligence and declined guilt: Retailing morality comparison between human and AI. *J. Bus. Ethics* 178, 1027–1041. doi: 10.1007/s10551-022-05056-7

Habib, M. D., and Qayyum, A. (2018). Cognitive emotion theory and emotion-action tendency in online impulsive buying behavior. *J. Manag. Sci.* 5, 86–99. doi: 10.20547/jms.2014.1805105

Han, D., Lalwani, A. K., and Duhachek, A. (2017). Power distance belief, power, and charitable giving. *J. Consum. Res.* 44, 182–195.

Hoch, S. J., and Loewenstein, G. F. (1991). Time-inconsistent preferences and consumer self-control. *J. Consum. Res.* 17, 492–507. doi: 10.1086/208573

Huang, J. S., Pan, S. L., and Liu, J. (2017). Boundary permeability and online–offline hybrid organization: A case study of Suning, China. *Inf. Manag.* 54, 304–316. doi: 10.1016/j.im.2016.08.002

Inesi, M. E. (2010). Power and loss aversion. *Organ. Behav. Hum. Decis. Process.* 112, 58–69. doi: 10.1016/j.obhdp.2010.01.001

Jia, Y., Wyer, R. S ., and Shen, H. (2020). "Will you?" versus "can you?": Verbal framing moderates the effect of feelings of power on consumers' reactions to waiting. *J. Exp. Psychol. Appl.* 27, 213–227. doi: 10.1037/xap0000336

Jin, F., and Zhu, H. W. (2016). Consumers' power states and impulsive purchasing. *Acta Psychol. Sin.* 48, 880–890. doi: 10.3724/SP.J.1041.2016.00880

Jin, L., He, Y. Q., and Zhang, Y. (2014). How power states influence consumers' perceptions of price unfairness. *J. Consum. Res.* 40, 818–833. doi: 10.1086/673193

Keltner, D., Gruenfeld, D. H., and Anderson, C. (2003). Power, approach, and inhibition. *Psychol. Rev.* 110, 265–284. doi: 10.1037/0033-295x.110.2.265

Khan, U., and Dhar, R. (2010). Price framing effects on purchase of hedonic and utilitarian bundles. *J. Mark. Res.* 47, 1090–1099.

Kim, S., and McGill, A. L. (2011). Gaming with Mr. Slot or gaming the slot machine? Power, anthropomorphism, and risk perception. *J. Consum. Res.* 38, 94–107. doi: 10.1086/658148

Kivetz, R., and Simonson, I. (2002). Earning the right to indulge: Effort as a determinant of customer preferences towards frequency program rewards. *J. Mark. Res.* 39, 155–170. doi: 10.1509/jmkr.39.2.155.19084

Kivetz, R., and Zheng, Y. (2006). Determinants of justification and self-control. *J. Exp. Psychol. Gen.* 135, 572–587.

Kivetz, R., and Zheng, Y. H. (2017). The effects of promotions on hedonic versus utilitarian purchases. *J. Consum. Psychol.* 27, 59–68.

Levav, J., and McGraw, P. A. (2009). Emotional accounting: How feelings about money influence consumer choice. *J. Mark. Res.* 46, 66–80. doi: 10.1509/jmkr.46.1.66

Li, B., Hu, M., Chen, X., and Lei, Y. (2021). The moderating role of anticipated regret and product involvement on online impulsive buying behavior. *Front. Psychol.* 12:732459. doi: 10.3389/fpsyg.2021.732459

Li, F., Wang, G., Li, Y., and Zhou, R. (2017). Job demands and driving anger: The roles of emotional exhaustion and work engagement. *Accid. Anal. Prev.* 98, 198–205. doi: 10.1016/j.aap.2016.10.013

Li, M., Yang, F., and Han, Y. (2022). More power, more warmth: The enhancing effect of power on the perceived warmth about high-power individuals under Chinese culture. *Front. Psychol.* 13:874861. doi: 10.3389/fpsyg.2022.874861

Luo, N., Zhang, M., Hu, M., and Wang, Y. (2016). How community interactions contribute to harmonious community relationships and customers' identification in online brand community. *Int. J. Inf. Manag.* 36, 673–685. doi: 10.1016/j.ijinfomgt.2016.04.016

Luo, X. M. (2005). How does shopping with others influence impulsive purchasing? *J. Consum. Psychol.* 15, 288–294.

Magee, J. C., and Galinsky, A. D. (2008). Social hierarchy: The self-reinforcing nature of power and status. *Acad. Manag. Ann.* 2, 351–398.

Magee, J. C., and Smith, P. K. (2013). The social distance theory of power. *Pers. Soc. Psychol. Rev.* 17, 158–186. doi: 10.1177/1088868312472732

Mourali, D., and Yang, Z. Y. (2013). The dual role of power in resisting social influence. *J. Consum. Res.* 40, 539–554. doi: 10.1086/671139

Pang, J., Song, Z., and Lv, Y. (2014). Desire for revenge and desire for avoidance: The gender differences in consumers' responses to utilitarian vs. hedonic product failure. *Manag. Rev.* 26, 92–103.

Piff, P. K., Michael, W. K., Stephane, C., Bonnie, H. C., and Dacher, K. (2010). Having less, giving more: The influence of social class on prosocial behavior. *J. Pers. Soc. Psychol.* 99, 771–784. doi: 10.1037/a0020092

Rook, D. W. (1987). The buying impulse. *J. Consum. Res.* 14, 189–199. doi: 10.1086/209105

Rook, D. W., and Fisher, R. J. (1995). Normative influences on impulsive purchasing behavior. *J. Consum. Res.* 22, 305–313. doi: 10.1086/209452

Rucker, D. D., David, D., and Galinsky, A. D. (2011). Generous paupers and stingy princes: Power drives consumer spending on self versus others. *J. Consum. Res.* 37, 1015–1029. doi: 10.1086/657162

Rucker, D. D., and Galinsky, A. D. (2008). Desire to acquire: Powerlessness and compensatory consumption. *J. Consum. Res.* 35, 257–267. doi: 10.1086/588569

Rucker, D. D., and Galinsky, A. D. (2009). Conspicuous consumption versus utilitarian ideals: How different levels of power shape consumer behavior. *J. Exp. Soc. Psychol.* 45, 549–555. doi: 10.1016/j.jesp.2009.01.005

Rucker, D. D., Galinsky, A. D., and Dubois, D. (2012). Power and consumer behavior: How power shapes who and what consumers' value. *J. Consum. Psychol.* 22, 352–368. doi: 10.1016/j.jcps.2011.06.001

Rucker, D. D., Hu, M., and Galinsky, A. D. (2014). The experience versus the expectations of power: A recipe for altering the effects of power on behavior. *J. Consum. Res.* 41, 381–396. doi: 10.1086/676598

Shiv, B., and Fedorikhin, A. (1999). Heart and mind in conflict: The interplay of affect and cognition in consumer decision making. *J. Consum. Res.* 26, 278–292. doi: 10.1086/209563

Smith, P. K., and Trope, Y. (2006). You focus on the forest when you're in charge of the trees: Power priming and abstract information processing. *J. Pers. Soc. Psychol.* 90, 578–596. doi: 10.1037/0022-3514.90.4.578

Wang, M., Shi, W., Yan, B., and Yang, F. (2017). Power stereotypes: The content and effects on spontaneous trait inferences. *Chin. J. Clin. Psychol.* 3, 406–411. doi: 10.16128/j.cnki.1005-3611.2017.03.003

Xu, J., and Schwarz, N. (2009). Do we really need a reason to indulge? *J. Mark. Res.* 46, 25–36. doi: 10.1509/jmkr.46.1.25

Zhang, S., Zhong, Y., and Luo, M. (2015). A study of implicit stereotype of power: Based on IAT and GANT measure. *Chin. J. Clin. Psychol.* 1, 56–59. doi: 10.16128/j.cnki.1005-3611.2015.01.012

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 22 March 2023
DOI 10.3389/fpsyg.2023.1120925

Check for updates

OPEN ACCESS

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SPECIALTY SECTION
This article was submitted to Movement Science and Sport Psychology, a section of the journal Frontiers in Psychology

RECEIVED 10 December 2022
ACCEPTED 21 February 2023
PUBLISHED 22 March 2023

CITATION
Liu Y, Feng Q, Tong Y and Guo K (2023) Effect of physical exercise on social adaptability of college students: Chain intermediary effect of social-emotional competency and self-esteem.
Front. Psychol. 14:1120925.
doi: 10.3389/fpsyg.2023.1120925

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Effect of physical exercise on social adaptability of college students: Chain intermediary effect of social-emotional competency and self-esteem

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Objective: To explore the relationship between physical exercise and college students' social adaptability, as well as the mediating role of social-emotional competency and self-esteem.

Methods: One thousand two hundred thirty college students were investigated by physical exercise questionnaire, social-emotional competency scale, self-esteem scale, and social adaptability scale. Data were analyzed by Pearson correlation analysis, structural equation model test and deviation-corrected percentile Bootstrap method.

Results: (1) Physical exercise was positively correlated with social adaptability (r=0.397, p<0.01), and the direct path of physical exercise on social adaptability was significant (β=0.397, t=15.174, p<0.01). (2) Physical exercise positively predicted social-emotional competency (β=0.399, t=15.235, p<0.01) and self-esteem (β=0.305, t=10.570, p<0.01). Social-emotional competency positively predicted self-esteem (β=0.130, t=4.507, p<0.01) and social adaptability (β=0.169, t=6.104, p<0.01). Self-esteem positively predicted social adaptability (β=0.189, t=6.957, p<0.01). (3) Social-emotional competency and self-esteem play a significant mediating role between physical exercise and social adaptability. The mediating effect includes three paths: physical exercise→social-emotional competency→social adaptability (the mediating effect value: 0.068); physical exercise→self-esteem→social adaptability (the mediating effect value: 0.059). Physical exercise→social-emotional competency→self-esteem→social adaptability (the mediating effect value: 0.010).

Conclusion: Physical exercise can not only directly affect social adaptability of college students, but also indirectly affect social adaptability through the independent intermediary role of social-emotional competency and self-esteem. Furthermore, physical exercise also affect social adaptability through the chain mediation of social-emotional competency and self-esteem.

KEYWORDS

physical exercise, social adaptability, social-emotional competency, self-esteem, college students

Introduction

Social adaptability refers to the adaptive ability of people to make psychological, physiological, and behavioral changes to better survive in society and achieve a harmonious state with society. The subject can adjust their behavior to adapt to interpersonal communication, including social ability, coping ability, interpersonal relationship ability, etc. (Chung et al., 2011). Social adaptability is the core of modern moral education and quality education and an essential goal for the healthy development of college students (Yang, 2002; Chi et al., 2016). The Chinese Ministry of Education puts forward the guiding ideology of "people-oriented, health first" in August 2002, that is, sports participation, sports skills, physical health, mental health, and social adaptation. Social adaptation is the essential overarching goal. Social adaptability is an indispensable ability for college students. It is also an important responsibility of colleges to cultivate college students' social adaptability. High social adaptability can help college students relieve pressure, regulate negative emotions, control aggressive behavior, and promote their mental health (Ji and Zheng, 2021). However, college students with poor social adaptability often find it difficult to adapt to the school environment, easy to produce negative emotions such as inferiority, weariness, and other psychological barriers, which affect their physical and mental health (Li and Li, 2015). Therefore, exploring the influencing factors of college students' social adaptability is conducive to promoting their positive adaptation to the environment, overcoming difficulties, and improving the mental health status of college students.

Physical exercise and social adaptability

The physical and mental health of college students has always been a hot topic in the sports field. Researchers have generally recognized that physical exercise is an effective intervention means for college students to develop positive psychological traits and promote physical and mental development over the years. Generally speaking, college students who engage in physical exercise actively are better at communicating with others, sharing fun, establishing friendly interpersonal networks, and developing interpersonal relationships. College students who often participate in physical exercise have strong interpersonal management, and emotional regulation abilities, as well as healthy psychology (Vankim and Nelson, 2013). Therefore, they are also more socially adaptable (Ji and Zheng, 2021). Conversely, negative behavior, such as lower exercise dependence often leads to negative self-presentation, susceptibility to loneliness and social exclusion, which blocks the development of social adaptability (Liu et al., 2021). It is found that the social adaptability of college students is related to the number of times, the duration and the intensity of sports activities (Chen and Sto, 2021). The more students participate in sports activities, the better their social adaptability will be (Chen and Sto, 2021).

Although studies have explored the impact of physical exercise on college students' social adaptability (Chen and Sto, 2021; Ji and Zheng, 2021), the research on the internal mechanism and mediating role of physical activity and social adaptability has not been fully revealed. By studying the influence of physical exercise on college students' social adaptability and the mediating role of social-emotional competency and self-esteem between physical exercise and social adaptability, this study can not only further enrich the research scope at the theoretical level, but also provide empirical evidence for improving college students' social adaptability at the practical level. Therefore, hypothesis 1 is proposed in this study: physical exercise can positively predict college students' social adaptability.

Mediating effect of social-emotional competency

Social-emotional competency refers to the ability of an individual to acquire and effectively apply knowledge, attitudes and skills to understand and manage emotions, set and achieve positive goals, express empathy for the feelings of others, establish and maintain positive relationships with peers, and make responsible decisions (Wang et al., 2019). Physical exercise has an important effect on social-emotional competency (Goh et al., 2022). Social-emotional competency mainly includes social competency and emotional competency (Choi and Gwag, 2017). Studies have shown that physical exercise has a positive effect on social competency and emotional control skills (Jiang et al., 2018; Liu J. et al., 2022). Lack of social-emotional competency is the root cause of various psychological and behavioral problems, which seriously hinder students' academic progress and the growth of body and mind (Rautakoski et al., 2021). Improving social-emotional competency can significantly improve students' academic performance, establish positive peer relationship, enhance emotional health and communication skills (Durlak et al., 2011), and improve social adaptability. Research has shown that social competency and emotional understanding ability can predict social adaptability (Yu, 2018). A study by Huang et al. (2021) revealed that social-emotional competency can significantly predict the social adaptability of middle school students. Therefore, social-emotional competency may be an important factor affecting social adaptability. College students who regularly participate in physical exercise have more robust social competency and emotional regulation ability, better mental health, and better social adaptability (Xiao, 2007; Yin et al., 2015). In conclusion, physical exercise may affect college students' social adaptability through social-emotional competency. Accordingly, hypothesis 2 is proposed in this study: social-emotional competency is the mediating variable between physical exercise and the social adaptability of college students.

Mediating effect of self-esteem

Self-esteem refers to the individual's evaluation or emotional response to their physical characteristics, personality, social identity, and behavior. It is the psychological component of the personality self-regulation structure (Pearlin, 1989). A deeper understanding of the concept of self-esteem includes self-value, self-acceptance, self-efficacy, attitude toward oneself, and self-respect (Doré, 2017).Self-esteem can be used to measure a person's mental health. The study confirmed that self-esteem is one of the leading contributors to anxiety for college students. Cultivating self-esteem of students is important for alleviating their anxiety issues and improving their mental health at college (Liu X. et al., 2022). Studies have found that physical exercise significantly impacts self-esteem (Shang et al., 2021; Chen et al., 2022). Physical exercise can not only enhance the physical fitness of

individuals but also improve the level of self-esteem and self-concept, thus affecting the mental health of individuals (Sonstroem, 1984). The active participation of physical exercise can improve body self-evaluation, increase the level of individual self-esteem, and improve subjective well-being of college students (Shang et al., 2021).

There is a significant correlation between self-esteem and social adaptability (Zhang, 2013). As an interpersonal monitor, self-esteem can regulate interpersonal relations and make them more harmonious (Bale and Archer, 2013). Individuals with high self-esteem may also be more likely to identify and use different personal and contextual coping resources (e.g., seek and receive more social support), which may, in turn, facilitate positive coping behavior and adjustment (Boden et al., 2008), so the more socially resilient they are. It is worth pointing out that, as a kind of challenging social practice, physical exercise is often accompanied by difficulty overcoming, task challenges, self-improvement and goal realization. Therefore, individuals may constantly experience learning, coping and self-presentation during exercise practice process so as to improve self-esteem, self-concept level as well as social adaptability (Biddle and Asare, 2011; Lubans et al., 2016). It can be inferred that physical exercise can affect college students' social adaptability through self-esteem. Therefore, hypothesis 3 is proposed in this study: self-esteem is the mediating variable between physical exercise and college students' social adaptability.

Chain mediating effect of social-emotional competency and self-esteem

Sociometer theory proposes that self-esteem is an adaptation that evolved to monitor and regulate interpersonal relationships (Leary and Baumeister, 2000; Mann and Blumberg, 2022). Low self-esteem is associated with social phobia (Perczel-Forintos and Kresznerits, 2017). Social competency plays a crucial role in the formation of self-esteem (Mayordomo et al., 2020). Emotional competency is also closely related to self-esteem (Barrera et al., 2019). Therefore, there is a close relationship between social-emotional competency and self-esteem (Barrera et al., 2019). It is found that the cultivation of social-emotional competency can improve individual self-esteem (Heiman and Olenik-Shemesh, 2020). In other words, social-emotional competency affects self-esteem. Therefore, hypothesis 4 is proposed in this study: social-emotional competency and self-esteem play a chain mediating role between physical exercise and social adaptability.

Hypotheses of this study

To sum up, in order to investigate the internal mechanism between physical exercise and social adaptability, this study plans to build a chain mediating model (Figure 1). According to the hypothetical structure model, we will verify the following aspects: (1) Physical exercise can positively predict college students' social adaptability; (2) Social-emotional competency plays an independent intermediary role between physical exercise and social adaptability of college students; (3) Self-esteem plays an independent intermediary role between physical exercise and social adaptability of college students; (4) Social-emotional competency and self-esteem play a chain intermediary role between physical exercise and social adaptability. In conclusion, based on verifying the above hypotheses, this study aims to explore further rrelationship between physical exercise, social-emotional competency, self-esteem, and social adaptability, to reveal the chain mediating role of social-emotional competency and self-esteem between physical exercise and social adaptability of college students, and to provide a theoretical basis for improvement of the college students' social adaptability.

Materials and methods

Participants and procedure

In this study, a convenience sampling method was adopted to collect data from the students of Zhaoqing University. Pre-survey training was conducted for investigators. After the consent of the school leaders, teachers, and the subjects themselves, the group test was adopted, and the principles of voluntary filling, data confidentiality, and anonymous filling were emphasized to complete the questionnaire. A total of 1,317 questionnaires were sent out, and 1,230 valid questionnaires were collected after excluding invalid questionnaires caused by the regular responses and missing data, with an effective recovery rate of 93.40% (342 in junior one, 329 in junior two, 296 in junior three, and 263 in junior four). Among the

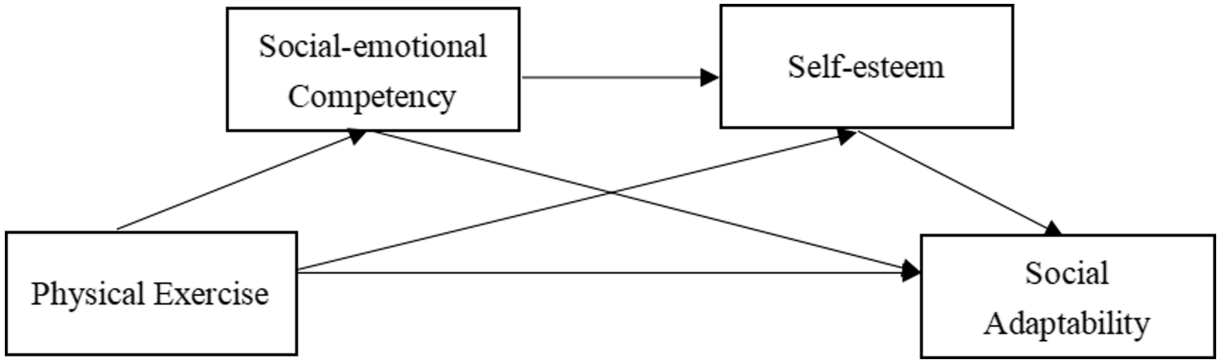

FIGURE 1
The hypothetical structure model.

participants, 632 were male (51.4%), and 598 were female (48.6%). The average age of the subjects was 20.39 ± 1.43 years old. This study was approved by the Research Ethics Committee of Zhaoqing University. All subjects were informed of the research purpose and signed informed consent.

Physical exercise questionnaire

College students' physical exercise questionnaire revised by Wu (2016) was adopted, which was adapted from the physical exercise commitment Intention Scale compiled by Chen et al. (2006). The questionnaire consists of 8 questions, including two dimensions of physical exercise commitment and persistence. The scale adopts the Likert 5 points scoring method, and each item is scored from 1 (strongly disagree) to 5 (strongly agree). The higher total score indicates a higher level of physical activity. It is proven that the scale has good reliability and validity in Chinese college students (Jiang et al., 2018). In this study, Cronbach's α coefficient of this scale is 0.91. The fitting index of confirmatory factor analysis of the scale: χ^2/df = 3.941, GFI = 0.986, AGFI = 0.973, IFI = 0.991, TLI = 0.987, CFI = 0.991, RMSEA = 0.049, indicating that the scale has good reliability and validity.

Social-emotional competency scale

The social-emotional competency scale of this study adopted the Delaware Social Emotional Competency Scale, revised by Zhu (2016). The scale consists of 12 items, including four dimensions: social perception, self-management, peer relationship, and responsible decision-making. Likert 4-point scoring is adopted, from "1 = not like me at all" to "4 = very like me," and "I blame others when I am in trouble" is the reverse scoring question. The higher the score is, the higher the social-emotional competency. The scale shows high reliability and validity in Chinese college students (Chu et al., 2021). In this study, Cronbach's α coefficient of this scale is 0.90. The fitting index of confirmatory factor analysis of the scale: χ^2/df = 3.240, GFI = 0.979, AGFI = 0.966, IFI = 0.986, TLI = 0.980, CFI = 0.986, RMSEA = 0.043, indicating that the scale has good reliability and validity.

Self-esteem scale

The self-esteem scale modified by Rosenberg (1965) and Wang et al. (1999) was adopted. The scale consists of 10 questions in one dimension. Likert 4-point scoring is adopted, from "1 = completely inconsistent" to "4 = very consistent." There are 6 forward-scoring questions and 4 reverse-scoring questions. A higher scale score indicates a higher level of self-esteem. The scale shows high reliability and validity in Chinese college students (Wan and An, 2022). In this study, Cronbach's α coefficient of this scale is 0.85. The fitting index of confirmatory factor analysis of the scale: χ^2/df = 4.921, GFI = 0.975, AGFI = 0.958, IFI = 0.978, TLI = 0.970, CFI = 0.978, RMSEA = 0.056, indicating that the scale has good reliability and validity.

Social adaptability scale

The scale of social adaptability developed by Zheng (1999) was adopted. The scale consists of 20 items, including 5 dimensions: dealing with peer relationship skills, self-management skills, learning skills, obedience skills, and willingness to express skills. It aims to evaluate the social adaptability of college students from both positive and negative aspects. Likert 3-point scoring is adopted, "1 = yes" and "3 = no." The higher the scale score is, the better the social adaptability. In this study, Cronbach's α coefficient of this scale is 0.85.

Statistical analysis

Statistical software Spss26.0 and Amos26.0 were used to analyze the data obtained. After the questionnaires were collected, confirmatory factor analysis was performed for all questionnaires using Amos26.0. Harman single-factor method was used to test the standard method deviation of the data. Spss26.0 was used for Pearson correlation analysis to examine the relationship among physical exercise, social-emotional competency, self-esteem, and social adaptability. Spss26.0 plug-in process was applied to examine the relationship model and mediating effect of college students' physical exercise, social-emotional competency, self-esteem, and social adaptability. Normally distributed continuous variables are expressed as mean (M) ± standard deviation (SD). According to the references, χ^2/df is less than 5, GFI, AGFI, IFI, TLI, and CFI are more significant than 0.8, and RMSEA is less than 0.08, which is acceptable. In this study, the significance level was set as $p < 0.05$.

Results

Common method deviation test

To ensure the accuracy of the statistical analysis results, the most commonly used Harman single-factor method was adopted in this study. A common method deviation test was carried out for the data in this paper, that is, exploratory factor analysis was done for all items of the scale together, and principal component analysis was adopted to extract components with an eigenvalue greater than 1. The test results showed that a total of 12 common factors with eigenvalues greater than 1 were extracted. The explanatory variance of the first factor without rotation was 20.737%, which was less than the critical value of 40% (Podsakoff et al., 2003). There was no single common factor to explain most of the variation. Therefore, there is no serious common method bias problem in this study.

Descriptive statistics and correlation analysis

As shown in Table 1, the correlation coefficients of physical exercise, social-emotional competency, self-esteem, and social adaptability are all statistically significant. Correlation analysis shows that physical exercise is significantly positively correlated with social-emotional competency, self-esteem, and social adaptability. Social-emotional

competency is significantly positively correlated with self-esteem and social adaptability. Additionally, there is a significant positive correlation between self-esteem and social adaptability. The correlation between variables supports the testing of subsequent hypotheses.

Examination of the mediating effects of social-emotional competency and self-esteem

According to Wen and Ye (2014)'s suggestions on the intermediary effect test, regression analysis is carried out on the chain intermediary effect model. The process v4.1 macro program model 6 developed by Hayes (2012) was used to test the mediating effect. With social-emotional competency and self-esteem as the mediating variables, physical exercise as the independent variable, and social adaptability as the dependent variable, the stepwise regression method was used to test the mediating effect. The analysis results are shown in Table 2.

As shown in Table 2, physical exercise can significantly and positively predict the social adaptability among college students ($\beta = 0.397$, $p < 0.01$). Therefore, hypothesis 1 is verified. After incorporating social-emotional competency into the regression equation, physical exercise significantly positively predicts social-emotional competency ($\beta = 0.399$, $p < 0.01$), and social-emotional competency significantly positively predicts social adaptability ($\beta = 0.169$, $p < 0.01$). Hypothesis 2 is verified. After incorporating self-esteem into the regression equation, physical exercise significantly positively predicts self-esteem ($\beta = 0.305$, $p < 0.01$), and self-esteem significantly positively predicts social adaptability ($\beta = 0.189$, $p < 0.01$). Hypothesis 3 is verified. After integrating social-emotional competency and self-esteem into the regression equation, social-emotional competency significantly positively predicts self-esteem ($\beta = 0.130$, $p < 0.01$), indicating the existence of chain mediation between social-emotional competency and self-esteem. Hypothesis 4 is verified. It can be concluded that social-emotional competency and self-esteem play a chain mediating role between physical exercise and the social adaptability of college students.

The deviation-corrected percentile Bootstrap method (repeated sampling 5,000 times) was used to test the mediating effects of social-emotional competency and self-esteem between physical exercise and social adaptability. Results of the mediation effect Bootstrap 95% confidence interval are shown in Table 3. Physical exercise→social-emotional competency→social adaptability, the confidence interval is [0.053, 0.108], excluding 0, and the mediating effect value is 0.068, indicating that social-emotional competency is the mediating variable between physical exercise and social adaptability of college students. Physical exercise→self-esteem→ social-emotional competency, the confidence interval is [0.046, 0.092], excluding 0, and the mediating effect value is 0.059, indicating that self-esteem is the mediating variable between physical exercise and social-emotional competency of college students. Physical exercise→social-emotional competency→self-esteem→social adaptability, the confidence interval is [0.006, 0.018], excluding 0, and the mediating effect value is 0.010, indicating that the chain mediating effect between physical exercise and social adaptability of college students is significant (Figure 2). The mediating effect of social-emotional competency and self-esteem on physical exercise and social adaptability is shown in Figure 2.

Discussion

This study explores the relationship between physical exercise and college students' social adaptability, as well as the mediating effect between social-emotional competency and self-esteem. The results show that physical exercise can not only positively affect social

TABLE 1 Means, standard deviations, and correlations among variables.

Variable	*M*	SD	1	2	3	4
1. Physical exercise	22.50	6.493	1			
2. Social-emotional competency	29.60	7.499	0.399**	1		
3. Self-esteem	27.01	7.374	0.357**	0.252**	1	
4. Social adaptability	41.52	7.623	0.397**	0.321**	0.325**	1

$N = 1{,}230$. **$p < 0.01$; all tests were two-tailed.

TABLE 2 Analysis of regression relationship of variables.

	Social adaptability		Social-emotional competency		Self-esteem		Social adaptability	
	β	*t*	*β*	*t*	*β*	*t*	*β*	*t*
Physical exercise	0.397	15.174***	0.399	15.235***	0.305	10.570***	0.262	9.133***
Social-emotional competency					0.130	4.507***	0.169	6.104***
Self-esteem							0.189	6.957***
R	0.397		0.399		0.376		0.469	
R^2	0.158		0.159		0.141		0.220	
F	230.236***		232.090***		101.076***		115.448***	

***$p < 0.001$.

TABLE 3 Mediation effect test based on Bootstrap.

		Effect	Boot SE	Boot LLCI	Boot ULCI	Ratio of indirect to total effect
Total effect		0.397	0.032	0.403	0.530	
Direct effect		0.260	0.035	0.240	0.377	65.49%
	Total indirect effect	0.137	0.018	0.125	0.197	34.51%
Indirect effect	Indirect effect 1	0.068	0.014	0.053	0.108	17.13%
	Indirect effect 2	0.059	0.012	0.046	0.092	14.86%
	Indirect effect 3	0.010	0.003	0.006	0.018	2.52%
	Compare 1	0.011	0.020	−0.026	0.052	
	Compare 2	0.068	0.014	0.042	0.097	
	Compare 3	0.056	0.012	0.034	0.081	

Boot SE and Boot LLCI and Boot ULCI, respectively, refer to the standard error of effect and lower and upper limits of 95% confidence interval estimated by Bootstrap deviation correction method. Indirect effect 1: Physical exercise→social-emotional competency→social adaptability; Indirect effect 2: Physical exercise→self-esteem→social adaptability; Indirect effect 3: Physical exercise→social-emotional competency→self-esteem→social adaptability.

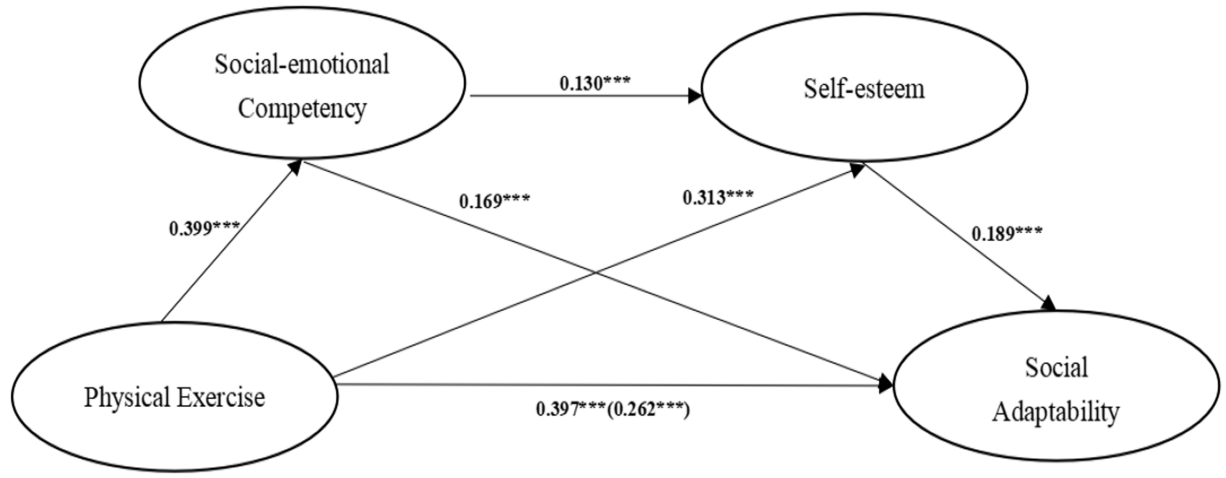

FIGURE 2
Chain mediation model of social-emotional competency and self-esteem between physical exercise and social adaptability (***p<0.001).

adaptability, but also indirectly affect social adaptability through the independent mediating effect of social-emotional competency and self-esteem. Furthermore, physical exercise also affect social adaptability through the chain mediation of social-emotional competency and self-esteem. Besides, this paper further explains the causes of the effect of physical exercise on social adaptability in college students and has certain enlightenment significance for the prevention and intervention of social adaptability in college students.

The relationship between physical exercise and social adaptability

This study shows that there is a significant positive correlation between physical activity and social adaptability in college students, which is consistent with the results of previous relevant studies (Wu, 2018; Lu and Wang, 2019; Chen and Sto, 2021). Hypothesis 1 is tested. Social adaptability is a kind of ability to realize basic psychological needs, which reflect the individual's ability to socialize, communicate and do things. Generally speaking, college students who engage in physical exercise actively are better at communicating with others, sharing fun, establishing social interpersonal networks, and developing interpersonal relationships. Physical exercise can not only strengthen the body of college students, but also cultivate their personality and develop interpersonal communication skills. A previous study revealed that physical exercise was the causal variable of adolescents' social adaptability, while urging and encouraging adolescents to engage in physical exercise activities may effectively improve their social adaptability (Zhu and Shu, 2022).

The experimental researches on the influence of physical exercise on the social adaptability of college students are also consistent with the results of this study. One study found that after the intervention of extracurricular physical exercise, the level of college students' social adaptability improved significantly, suggesting that extracurricular physical exercise can positively and effectively affect college students' social adaptability (Lu and Wang, 2019). Studies have also found that the social adaptability of non-physical exercise college students is significantly lower than that of physical training college students. The regression analysis results showed that physical exercise was the most important factor affecting the social adaptability of college students

(Wu, 2018). The study by Ji and Zheng (2021) revealed that physical exercise has a positive effect on college students' mental health and social adaptability. Their study further revealed that the social adaptability of college students is related to the number of times that they participate in sports activities, the duration of a single sports activity, as well as the intensity of sports activities. The more the college students participated in sports activities, the stronger their social adaptability is. Chen and Sto (2021) pointed out that if college students keep the appropriate duration and intensity of sports activities, their interpersonal communication ability and social adaptability will be improved notably. Therefore, physical exercise is beneficial to improve college students' social adaptability.

The mediating effect of social-emotional competency

In this study, we find that social-emotional competency plays a mediating role between physical exercise and social adaptability, which verifies hypothesis 2. This finding is consistent with the conclusions of previous studies, namely, physical exercise positively predicts social-emotional competency (Jiang et al., 2018), and social-emotional competency positively predicts social adaptability (Huang et al., 2021). In this study, three variables were examined at the same time, revealing that physical exercise is an important predictor of improving social-emotional competency and social adaptability.

First, this study confirms that physical exercise can positively predict social-emotional competency. Social-emotional competency includes social competency and emotional competency (Choi and Gwag, 2017). Emotional competency is an essential part of social-emotional competency (Beaudoin and Beauchamp, 2020). Physical exercise is an effective way to relieve tension, maintain emotional regulation, help regulate emotional impulses and promote mental health (Wagstaff, 2014). Physical exercise can effectively improve the self-efficacy of emotional regulation, maintain the positive emotions of college students, explore students' potential, and promote students' physical and mental health (Yin et al., 2015). Individuals with high self-efficacy are more confident in coping with emotions, especially negative emotions (Caprara et al., 2008). Studies found that emotional regulation self-efficacy also partially mediates the relationship between physical exercise and negative emotions among college students (Tang et al., 2022). Therefore, physical exercise can improve emotional competence through emotional regulation self-efficacy and emotional regulation strategies (Jiang et al., 2018). Poulos and Kulinna (2022) assessed the impact of an after-school curriculum aimed at improving physically active and inclusive play to promote physical, social, and emotional health. They found that, along with physical benefits, engaging in physical activity can support the social and emotional health of youth and promote health and well-being into adulthood.

Secondly, this study shows that social-emotional competency can positively predict social adaptability, that is, the improvement of social-emotional competency will directly promote the enhancement of social adaptability, which is also confirmed by previous studies (Huang et al., 2021). People with higher social-emotional competency often have stronger interpersonal ability, better communication skills with peers, and stronger social adaptability (Allen et al., 2005; Durlak et al., 2011). Domitrovich et al. (2017) pointed out that social-emotional competency is an essential factor for promoting positive adjustment and reducing risk in school children. The study also found that social-emotional competency can significantly predict the social adaptability of middle school students (Huang et al., 2021). People with strong social-emotional competency tend to have higher social ability and emotional regulation ability (Kendziora and Osher, 2016), as well as better psychological health and social adaptability. Therefore, physical exercise can improve the social adaptability of college students by enhancing their social-emotional competency.

The mediating effect of self-esteem

This study finds that self-esteem plays a mediating role between physical exercise and social adaptability, which verifies hypothesis 3. Previous studies have also confirmed this result, namely, physical exercise positively predicts self-esteem (Ekeland et al., 2004), and self-esteem further positively predicts social adaptability (Huang et al., 2021). In this study, the three variables were investigated at the same time, revealing that physical exercise is not only an important factor to improve individual self-esteem, but also an important factor to improve social adaptability.

This study proves that physical exercise positively predicts the self-esteem of college students. Studies have shown that physical activity positively affects self-esteem (Deng et al., 2022). Regular exercise improves the levels of self-efficacy, self-esteem, and body awareness of young adults (Gulsum et al., 2022). Physical self-concept changed by exercise participation might directly and positively influence mental well-being, and it can indirectly influence the changes in mental well-being *via* improving self-esteem (Kim and Ahn, 2021). Further research have shown that self-esteem was related to physical activity variables, such as physical condition, body mass index (BMI), and level of physical activity (Zurita-Ortega et al., 2017).

This study also confirms that self-esteem is an important predictor of social adaptability. Self-esteem is closely related to social adaptability (Mahadevan et al., 2019). The level of self-esteem of college students has a significant influence on their coping style (Xiong et al., 2008). Individuals with high self-esteem have enough confidence to accomplish something and also have high social adaptability (Zhang, 2013; Li, 2015). A longitudinal study of 642 college students showed that low self-esteem predicted social problems, and low self-esteem uniquely contributes to later social difficulties (Crocker and Luhtanen, 2003). College students with high self-esteem are more positive toward life, more active in face of different environment, more willing to actively adapt to the environment, to meet various challenges, and to achieve higher social adaptability. It is pointed out that positive response support from peers can help individuals achieve the desired goal and improve individual self-esteem (Feeney, 2004). One longitudinal study examined the relationship between self-esteem and depression among Chinese college students during four academic years. The results showed that the self-esteem levels of college students on average monotonically declined over years, and there were significant negative correlations between self-esteem and depression for college students (Gao et al., 2022). Physical exercise is conducive to the establishment of good peer relationships and improves self-esteem. Studies have shown that exercise affects health and also

supports a positive mindset of life and self-esteem (Wågan et al., 2021). Moreover, self-esteem enhancement is linked to better social interaction and healthier relationships (He, 2022). Therefore, physical exercise can improve college students' social adaptability through self-esteem.

The chain mediation effect of social-emotional competency and self-esteem

In this study, there is a significant positive correlation between social-emotional competency and self-esteem, which is consistent with the research results (Heiman and Olenik-Shemesh, 2020; Huang et al., 2021), further confirming the chain mediating role of social-emotional competency and self-esteem between physical exercise and social adaptability of college students, Hypothesis 4 is verified. It shows that the higher the social-emotional competency of college students is, the higher the level of self-esteem. Social-emotional competency is an important causal variable of self-esteem, which is consistent with previous studies (Huang et al., 2021). On the one hand, college students with higher social-emotional competency are easy to get acceptance and affirmation from the outside. Therefore, their self-concept is more stable and self-esteem is higher. According to the terror management theory put forward by Greenberg et al. (1997), self-esteem can buffer anxiety, and low self-esteem easily lead to individual depression, anxiety, and depression, thus inducing mental illness. Studies reported that people who have higher-quality interpersonal relationships also have higher levels of self-esteem. The overall level of self-esteem of citizens in different countries is positively correlated with the degree of close social interaction characteristics of individuals in the society (Denissen et al., 2008).

On the other hand, cultivating social-emotional competency can improve self-esteem (Heiman and Olenik-Shemesh, 2020), thus improving individual social adaptability. The research shows that social-emotional competency can not only directly improve the social adaptability of middle school students but also indirectly improve the social adaptability of middle school students through peer relationships and self-esteem (Huang et al., 2021). Social-emotional competency can affect social adaptability through self-esteem, maybe because college students with higher social-emotional competency tend to get more recognition in social interactions, and have more stable self-concepts and higher self-esteem. Furthermore, college students with high self-esteem have more positive life attitudes, more active coping ways in the face of problems or difficulties, and higher social adaptability. College students who often take part in physical exercise tend to have higher social-emotional competency and get more recognition in social communication (Wagstaff, 2014; Poulos and Kulinna, 2022). Studies show that people who have higher-quality interpersonal relationships also have higher levels of self-esteem (Denissen et al., 2008). Therefore, physical exercise can improve college students' social adaptability by improving social-emotional competency and self-esteem. In conclusion, social-emotional competency and self-esteem play a chain mediating role between physical exercise and social adaptability.

Practical implications

This study examines the relationship between physical exercise and college students' social adaptability, as well as the mediating role between social-emotional competency and self-esteem. It reveals the influence of physical exercise on college students' social adaptability and its possible mechanism, which has certain reference significance for improving the mental health of college students. The results of this study suggest that we should not only pay attention to the direct impact of physical exercise on college students' social adaptability but also improve their self-esteem and further enhance their social adaptability by improving their social-emotional competency through physical exercise. In practice, the following measures can be adopted: First of all, encourage college students to participate in physical activity, provide relevant scientific physical exercise guidance, promote the improvement of college students' social-emotional competency, self-esteem, and social adaptability, and then further improve the mental health of college students. Secondly, social-emotional competency and self-esteem are essential factors affecting college students' social adaptability. More attention should pay to the social-emotional competency and self-esteem of college students. We can improve the social-emotional competency and self-esteem of college students by developing some courses of learning social-emotional competency and self-esteem as well as introducing excellent foreign courses.

Research deficiencies and prospects

The findings of this study have particular theoretical values and practical guidance but also have some shortcomings. First, this study adopted a cross-sectional design because of space and time limitations. The longitudinal follow-up or experimental intervention study can increase in the post-study. Second, there are specific problems with the design and distribution of the questionnaire, making the subjects fill out the questionnaire with some concerns about catering to social acceptance factors. Third, this study only considers the mediating effect of social-emotional competency and self-esteem between physical exercise and social adaptability. Still, there may be other mediating variables that need further research.

Conclusion

(1) Physical exercise can significantly positively predict college students' social-emotional competency, self-esteem, and social adaptability, suggesting that physical exercise helps improve college students' social-emotional competency, self-esteem, and social adaptability. (2) Physical exercise can not only directly affect college students' social adaptability but also indirectly affect college students' social adaptability through the independent mediating effect of social-emotional competency and self-esteem. Physical exercise also indirectly affect social adaptability through the chain mediating effect of social-emotional competency and self-esteem. It is suggested that the promotion and intervention of college students' mental health should not only pay attention to enhancing their attitude and behavior toward physical exercise but also pay attention to improving their social-emotional competency and self-esteem.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Research Ethics Committee of Zhaoqing University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

YL and KG designed the study, collected and analyzed the data, and wrote the manuscript. QF and YT revised the manuscript. All authors contributed to the article and approved the submitted version.

Funding

This research was funded by (1) the Construction and practice of a practical teaching system of Physical Education Specialty in local Normal Colleges under the background of "New Normal" construction (2021GXJK482), Guangdong Province Education Science planning project; (2) the 2021 University-level Scientific Research Fund Project Outstanding young teachers scientific research ability enhancement plan, Research Project of Zhaoqing University; (3) Construction and practice of practical teaching system of Physical Education specialty in local Normal colleges under the background of university transformation (zlgc202135), Teaching Reform project of Zhaoqing University.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Allen, J. P., Porter, M. R., McFarland, F. C., Marsh, P., and McElhaney, K. B. (2005). The two faces of adolescents' success with peers: adolescent popularity, social adaptation, and deviant behavior. *Child Dev.* 76, 747–760. doi: 10.1111/j.1467-8624.2005.00875.x

Bale, C., and Archer, J. (2013). Self-perceived attractiveness, romantic desirability and self-esteem: a mating sociometer perspective. *Evol. Psychol.* 11:147470491301100. doi: 10.1177/147470491301100107

Barrera, U. D. L., Schoeps, K., Gil-Gómez, G. A., and Montoya-Castilla, I. (2019). Predicting adolescent adjustment and well-being: the interplay between socio-emotional and personal factors. *Int. J. Environ. Res. Public Health* 16:4650. doi: 10.3390/ijerph16234650

Beaudoin, C., and Beauchamp, M. H. (2020). Social cognition. *Handb Clin. Neurol.* 173, 255–264. doi: 10.1016/B978-0-444-64150-2.00022-8

Biddle, S. J., and Asare, M. (2011). Physical activity and mental health in children and adolescents: a review of reviews. *Br. J. Sports Med.* 45, 886–895. doi: 10.1136/bjsports-2011-090185

Boden, J. M., Fergusson, D. M., and Horwood, L. J. (2008). Does adolescent self-esteem predict later life outcomes? A test of the causal role of self-esteem. *Dev. Psychopathol.* 20, 319–339. doi: 10.1017/S0954579408000151

Caprara, G. V., Di Giunta, L., Eisenberg, N., Gerbino, M., Pastorelli, C., and Tramontano, C. (2008). Assessing regulatory emotional self-efficacy in three countries. *Psychol. Assess.* 20, 227–237. doi: 10.1037/1040-3590.20.3.227

Chen, S. P., Li, S. Z., and Yan, Z. L. (2006). Research on mechanism of exercise persistence based on sport commitment theory. *China Sport Sci.* 26, 48–55. doi: 10.16469/j.css.2006.12.010

Chen, R., Liu, Y. F., Huang, G. D., and Wu, P. C. (2022). The relationship between physical exercise and subjective well-being in Chinese older people: the mediating role of the sense of meaning in life and self-esteem. *Front. Psychol.* 13:1029587. doi: 10.3389/fpsyg.2022.1029587

Chen, Y., and Sto, C. (2021). Correlation of exercise style to mental health and social adaptability of college students. *Work* 69, 531–541. doi: 10.3233/WOR-213497

Chi, X., Lin, L., and Zhang, P. (2016). Internet addiction among college students in China: prevalence and psychosocial correlates. *Cyberpsychol. Behav. Soc. Netw.* 19, 567–573. doi: 10.1089/cyber.2016.0234

Choi, H. J., and Gwag, H. M. (2017). The influence of children's emotional control skills and social competence on adaptation to early childhood education institutes: with emphasis on gender and age difference. *J. Korea Open Assoc. Early Childhood Educ.* 22, 145–168. doi: 10.20437/koaece22-3-07

Chu, S. Y., Wang, J. H., Du, H. F., and Yu, H. X. (2021). Effect of self-focused attention on life satisfaction of college students: a chain mediating model. *Chin. J. Health Psychol.* 29, 1271–1275. doi: 10.13342/j.cnki.cjhp.2021.08.034

Chung, D., Yun, K., Kim, J. H., Jang, B., and Jeong, J. (2011). Different gain/loss sensitivity and social adaptation ability in gifted adolescents during a public goods game. *PLoS One* 6:e17044. doi: 10.1371/journal.pone.0017044

Crocker, J., and Luhtanen, R. K. (2003). Level of self-esteem and contingencies of self-worth: unique effects on academic, social, and financial problems in college students. *Personal. Soc. Psychol. Bull.* 29, 701–712. doi: 10.1177/0146167203029006003

Deng, C., Yu, Q., Luo, G., and Lu, S. (2022). Effects of 16 weeks of cheerleading on physical self-esteem and mental health of female college students. *Front. Psychol.* 13:925162. doi: 10.3389/fpsyg.2022.925162

Denissen, J. J., Penke, L., Schmitt, D. P., and van Aken, M. A. (2008). Self-esteem reactions to social interactions: evidence for sociometer mechanisms across days, people, and nations. *J. Pers. Soc. Psychol.* 95, 181–196. doi: 10.1037/0022-3514.95.1.181

Domitrovich, C. E., Durlak, J. A., Staley, K. C., and Weissberg, R. P. (2017). Social-emotional competence: An essential factor for promoting positive adjustment and reducing risk in school children. *Child Dev.* 88, 408–416. doi: 10.1111/cdev.12739

Doré, C. (2017). Self-esteem: concept analysis. *Rech. Soins Infirm.* 129, 18–26. doi: 10.3917/rsi.129.0018

Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., and Schellinger, K. B. (2011). Enhancing students' social and emotional development promotes success in school: results of a meta-analysis. *Child Dev.* 82, 405–432. doi: 10.1111/j.1467-8624.2010.01564.x

Ekeland, E., Heian, F., Hagen, K. B., Abbott, J., and Nordheim, L. (2004). Exercise to improve self-esteem in children and young people. *Cochrane Database Syst. Rev.* 1:CD003683. doi: 10.1002/14651858.CD003683.pub2

Feeney, B. C. (2004). A secure base: responsive support of goal strivings and exploration in adult intimate relationships. *J. Pers. Soc. Psychol.* 87, 631–648. doi: 10.1037/0022-3514.87.5.631

Gao, W. J., Luo, Y. F., Cao, X. J., and Liu, X. Q. (2022). Gender differences in the relationship between self-esteem and depression among college students: a cross-lagged study from China. *J. Res. Pers.* 97:104202. doi: 10.1016/J.JRP.2022.104202

Goh, T. L., Leong, C. H., Fede, M., and Ciotto, C. (2022). Before-school physical activity Program's impact on Social and emotional learning. *J. Sch. Health* 92, 674–680. doi: 10.1111/josh.13167

Greenberg, J., Solomon, S., and Pyszczynski, T. (1997). Terror management theory of self-esteem and cultural worldviews: empirical assessments and conceptual refinements. *Adv. Exp. Soc. Psychol.* 29, 61–139. doi: 10.1016/S0065-2601(08)60016-7

Gulsum, T., Ayse, U., and Filiz, A. (2022). Regular exercise improves the levels of self-efficacy, self-esteem and body awareness of young adults. *J. Sports Med. Phys. Fitness* 62, 157–161. doi: 10.23736/S0022-4707.21.12143-7

Hayes, A. F. (2012). PROCESS: A versatile computational tool for observed variable mediation, moderation, and conditional process modeling [white paper]. Available at: http://www.afayes.com/public/process2012.pdf (Assessed January 18, 2013).

He, X. (2022). Relationship between self-esteem, interpersonal trust, and social anxiety of college students. *Occup. Ther. Int.* 2022, 8088754–8088756. doi: 10.1155/2022/8088754

Heiman, T., and Olenik-Shemesh, D. (2020). Social-emotional profile of children with and without learning disabilities: the relationships with perceived loneliness, self-efficacy and well-being. *Int. J. Environ. Res. Public Health* 17:7358. doi: 10.3390/ijerph17207358

Huang, Z. W., Ye, B. J., Yang, Q., and Xu, L. (2021). Effect of Social and emotional competence on Social adjustment of junior middle school students: the chain mediating role of peer relationship and self-esteem. *Chin. J. Health Psychol.* 29, 1697–1702. doi: 10.13342/j.cnki.cjhp.2021.11.021

Ji, H., and Zheng, C. (2021). The influence of physical exercise on college students' mental health and social adaptability from the cognitive perspective. *Work* 69, 651–662. doi: 10.3233/WOR-213506

Jiang, Y., Zhang, L. W., and Mao, Z. X. (2018). Physical exercise and mental health: the effect of emotion regulation self-efficacy and emotion regulation strategy. *Stud. Psychol. Behav.* 16, 570–576.

Kendziora, K., and Osher, D. (2016). Promoting children's and adolescents' social and emotional development: district adaptations of a theory of action. *J. Clin. Child Adolesc. Psychol.* 45, 797–811. doi: 10.1080/15374416.2016.1197834

Kim, I., and Ahn, J. (2021). The effect of changes in physical self-concept through participation in exercise on changes in self-esteem and mental well-being. *Int. J. Environ. Res. Public Health* 18:5224. doi: 10.3390/ijerph18105224

Leary, M. R., and Baumeister, R. F. (2000). The nature and function of self-esteem: sociometer theory. *Adv. Exp. Soc. Psychol.* 32, 1–62. doi: 10.1016/S0065-2601(00)80003-9

Li, H. (2015). *A Study on Emotional Intelligence, Self-Esteem and Social Adjustment of Left-Behind Junior Middle School Students*. Ph.D. Thesis. Nanning: Guangxi University.

Li, Y. M., and Li, Y. X. (2015). The effect of interpersonal competence on social inferiority and mental health in adolescents: the role of social adaptation. *J. Psychol. Sci.* 38, 109–115. doi: 10.16719/j.cnki.1671-6981.2015.01.012

Liu, X., Cao, X., and Gao, W. (2022). Does low self-esteem predict anxiety among Chinese college students? *Psychol. Res. Behav. Manag.* 15, 1481–1487. doi: 10.2147/PRBM.S361807

Liu, Y., Liu, H., and Liu, Z. (2021). The relationship of self-presentation, psychological needs, and exercise dependence in college students with overweight. *Front. Psychol.* 11:625501. doi: 10.3389/fpsyg.2020.625501

Liu, J., Zhang, W. J., Shui, Y. Y., and Gao, S. Q. (2022). *The Positive Effects of Physical Exercise on Emotional Regulation: A Meta-Analysis Based on RCT. Summary of Papers of the 12th National Sports Science Conference–Special Report (Sports Psychology Branch)*, 3435–3436.

Lu, X. L., and Wang, K. (2019). Influence of extracurricular physical exercise on psychological capital， psychological health and social adaptability of college students. *Chin. J. Sch. Health* 40, 392–395. doi: 10.16835/j.cnki.1000-9817.2019.03.021

Lubans, D., Richards, J., Hillman, C., Faulkner, G., Beauchamp, M., Nilsson, M., et al. (2016). Physical activity for cognitive and mental health in youth: a systematic review of mechanisms. *Pediatrics* 138:e20161642. doi: 10.1542/peds.2016-1642

Mahadevan, N., Gregg, A. P., and Sedikides, C. (2019). Is self-regard a sociometer or a hierometer? Self-esteem tracks status and inclusion, narcissism tracks status. *J. Pers. Soc. Psychol.* 116, 444–466. doi: 10.1037/pspp0000189

Mann, R. B., and Blumberg, F. (2022). Adolescents and social media: the effects of frequency of use, self-presentation, social comparison, and self-esteem on possible self-imagery. *Acta. Psychol. (Amst)* 228:103629. doi: 10.1016/j.actpsy.2022.103629

Mayordomo, T., Gutierrez, M., and Sales, A. (2020). Adapting and validating the Rosenberg self-esteem scale for elderly Spanish population. *Int. Psychogeriatr.* 32, 183–190. doi: 10.1017/S1041610219001170

Pearlin, L. I. (1989). The sociological study of stress. *J. Health Soc. Behav.* 30, 241–256. doi: 10.2307/2136956

Perczel-Forintos, D., and Kresznerits, S. (2017). Social anxiety and self-esteem: Hungarian validation of the "brief fear of negative evaluation scale-straightforward items". *Orv. Hetil.* 158, 843–850. doi: 10.1556/650.2017.30755

Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., and Podsakoffff, N. P. (2003). Common method biases in behavioral research: a critical review of the literature and recommended remedies. *J. Appl. Psychol.* 88, 879–903. doi: 10.1037/0021-9010.88.5.879

Poulos, A., and Kulinna, P. H. (2022). A cluster randomized controlled trial of an after-school playground curriculum intervention to improve children's physical, social, and emotional health: study protocol for the PLAY ground project. *BMC Public Health* 22:1658. doi: 10.1186/s12889-022-13991-3

Rautakoski, P., Ursin, P. A., Carter, A. S., Kaljonen, A., Nylund, A., and Pihlaja, P. (2021). Communication skills predict social-emotional competencies. *J. Commun. Disord.* 93:106138. doi: 10.1016/j.jcomdis.2021.106138

Rosenberg, M. (1965). *Society and the Adolescent*. Princeton, NJ: Princeton University Press.

Shang, Y., Xie, H. D., and Yang, S. Y. (2021). The relationship between physical exercise and subjective well-being in college students: the mediating effect of body image and self-esteem. *Front. Psychol.* 12:658935. doi: 10.3389/fpsyg.2021.658935

Sonstroem, R. J. (1984). Exercise and self-esteem. *Exerc. Sport Sci. Rev.* 12, 156–155. doi: 10.1249/00003677-198401000-00007

Tang, S., Chen, H., Wang, L., Lu, T., and Yan, J. (2022). The relationship between physical exercise and negative emotions in college students in the post-epidemic era: the mediating role of emotion regulation self-efficacy. *Int. J. Environ. Res. Public Health* 19:12166. doi: 10.3390/ijerph191912166

Vankim, N. A., and Nelson, T. F. (2013). Vigorous physical activity, mental health, perceived stress, and socializing among college students. *Am. J. Health Promot.* 28, 7–15. doi: 10.4278/ajhp.111101-QUAN-395

Wågan, F. A., Darvik, M. D., and Pedersen, A. V. (2021). Associations between self-esteem, psychological stress, and the risk of exercise dependence. *Int. J. Environ. Res. Public Health* 18:5577. doi: 10.3390/ijerph18115577

Wagstaff, C. R. (2014). Emotion regulation and sport performance. *J. Sport Exerc. Psychol.* 36, 401–412. doi: 10.1123/jsep.2013-0257

Wan, H. D., and An, L. J. (2022). Understanding the relationship between perceived Social support and self-esteem of college students: the mediating role of attribution style and sense of security. *J. Hangzhou Normal Univ.* 21, 394–402. doi: 10.19926/j.cnki.issn.1674-232X.2022.04.009

Wang, X. D., Wang, X. L., and Ma, H. (1999). *Handbook of Mental Health Rating Scale*. Beijing: China Mental Health Journal.

Wang, Y., Yang, Z., Zhang, Y., Wang, F., Liu, T., and Xin, T. (2019). The effect of Social-emotional competency on child development in Western China. *Front. Psychol.* 10:1282. doi: 10.3389/fpsyg.2019.01282

Wen, Z. L., and Ye, B. J. (2014). Mediating effect analysis: method and model development. *Adv. Psychol. Sci.* 22, 731–745. doi: 10.3724/SP.J.1042.2014.00731

Wu, Z. Y. (2016). *Extension of the Cognitive Decision-Making Model of Exercise Persistence: Value-Added Contributions to Self-Regulation Processes and Emotional Experience*. Ph.D. thesis. Beijing, Beijing Sport University.

Wu, P. Y. (2018). *A Comparative Study on Social Adaptability of Physical Exercise and Non-Exercise College Students*. Ph.D. thesis. Chengdu: Chengdu Physical Education University.

Xiao, L. Q. (2007). The relation between physical exercise and college student's social adaptation ability. *J. Phys. Educ.* 14, 79–82. doi: 10.16237/j.cnki.cn44-1404/g8.2007.02.022

Xiong, C. Q., He, C. F., and Hou, Y. L. (2008). Relationship between self-esteem and coping styles of college students. *Chin. J. Health Psychol.* 16, 9–11. doi: 10.13342/j.cnki.cjhp.2008.01.040

Yang, G. P. (2002). *Investigation and Cultivation of Contemporary College Students' Social Adaptability*. Ph.D. thesis. Chongqing: Southwest Normal University.

Yin, L. Q., Li, J., and Tang, C. F. (2015). The relationship between physical exercise and emotional regulation self-efficacy in college students. *Contemp. Sports Technol.* 5, 94–95. doi: 10.16655/j.cnki.2095-2813.2015.36.094

Yu, Y. (2018). *A Study on the Relationship between 3–5 Year Old Children's Emotional Understanding, Parents' Meta-Emotional Concept and Children's Social Adjustment*. Ph.D. thesis. Xi'an: Shanxi Normal University.

Zhang, X. N. (2013). *A Study on the Relationship between Parenting Style, Self-Esteem and Social Adjustment of Pupils*. Ph.D. thesis. Shijiazhuang: Hebei Normal University.

Zheng, R. C. (1999). *Psychological Diagnosis of College Students*. Jinan: Shandong Education Press.

Zhu, X. X. (2016). *Reliability and Validity of the Chinese Version of the Delaware Social Emotional Competence Scale*. Ph.D. thesis. Changsha: Hunan Normal University.

Zhu, C., and Shu, S. (2022). Causal relationship between physical exercise and children and adolescents' Social adaptation: cross-lagged analysis. *China Sports Sci. Technol.* 33, 47–65. doi: 10.1177/0894845306289535

Zurita-Ortega, F., Castro-Sánchez, M., Rodríguez-Fernández, S., Cofré-Boladós, C., Chacón-Cuberos, R., Martínez-Martínez, A., et al. (2017). Physical activity, obesity and self-esteem in chilean schoolchildren. *Rev. Med. Chil.* 145, 299–308. doi: 10.4067/S0034-98872017000300006

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 05 May 2023
DOI 10.3389/fpsyg.2023.1077458

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OPEN ACCESS

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RECEIVED 23 October 2022
ACCEPTED 05 April 2023
PUBLISHED 05 May 2023

CITATION
Wu W, Mitchell P and Lv Y (2023) Consistency in personality trait judgments across online chatting and offline conversation. *Front. Psychol.* 14:1077458. doi: 10.3389/fpsyg.2023.1077458

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Consistency in personality trait judgments across online chatting and offline conversation

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Past research has suggested that people utilize various non-verbal cues to make personality judgments in either real-world or online environments, but little is known about the extent to which a person would be perceived consistently across realistic and virtual contexts. The present study was to investigate this issue, exploring the extent to which the same target was judged consistently in terms of empathic and big-five traits across online text-based chatting and offline conversation, and to pinpoint how the judgments occurred in the two contexts. In the formal procedure, 174 participants were asked to make trait judgments and evaluate the observable cues about the partner after chatting online and after watching the partner (who the participant did not know was the same person in the online chatting) in a real-world conversation. The results demonstrated the following: (1) Participants made consistent judgments of each trait about the same target across the online chatting and the offline conversation; (2) many cues in each context were employed to drive trait judgments, whereas few cues validly revealed the self-reported assessments of the traits. The results were discussed based on the empirical and theoretical work in person perception.

KEYWORDS

personality trait judgments, online chatting, real-world conversation, judgmental consistency, person perception

Introduction

With the widespread application of various social media (such as Facebook, Twitter, and WeChat), social life expands from traditional face-to-face interaction to diverse virtual communications, such as online chatting and sharing social activities on networking platforms. Like in the real world, people encounter others from all walks of life in the virtual environments, forming first impressions (Weisbuch et al., 2009), presenting oneself (Lee et al., 2014), and making trait judgments (Lee et al., 2014; Wu et al., 2021) from multiple observable "digital footprints." Past research has suggested that people form consistent personality impressions of strangers across different situations occurring in the real world (e.g., Borkenau et al., 2004; Wu et al., 2016a, 2017), but little is known about the extent

to which a person would be perceived consistently across realistic and virtual contexts. What cues might be available in the processes of personality judgments happening in daily conversation and in online communication? The current study sought to provide some insight into these issues.

Personality judgments in real-world and virtual contexts

Signals and cues of facial expressions and behavior embodied in psychological dispositions (Funder, 2012; Wu et al., 2016b) allow people to accurately judge some dimensions of the big-five traits (e.g., Carney et al., 2007; Thoresen et al., 2012; Back and Nestler, 2016) as well as the extreme levels of the empathic trait (Wu et al., 2016a) and the big-five traits (Wu et al., 2017). Similarly, "digital footprints" such as nicknames, profile images, and postings left on social media embodied in real personalities (Vazire and Gosling, 2004; Marcus et al., 2006; Back et al., 2010) enable people to infer some dimensions of the big-five traits (Tskhay and Rule, 2014; Azucar et al., 2018) and to detect those who are located at the extreme levels of the big-five trait continua (Wu et al., 2021). Based on this evidence, it seems reasonable to hypothesize a correspondence in personality trait judgments across online and offline contexts.

Indeed, Weisbuch et al. (2009) reported the very first empirical work, examining the consistency in first impressions of likeability across spontaneous behavior observed in real-world interaction and information abstracted from Facebook pages. In particular, participants' judgments of how much they liked their partner during the 5-min structured conversation were consistent with the judgments of liking the partners based on observing the details appearing on Facebook pages; participants were also asked to explain what informed their judgments. The results demonstrated that people could form a consistent first impression of likability on a given target across face-to-face interaction and the Facebook pages and revealed the valid information utilized in making these judgments (which included details from Facebook pages). Yet, this study did not reveal whether a given person would be perceived consistently by the same perceiver across the online and offline contexts. In Weisbuch et al. study, the target had a face-to-face conversation with a well-trained confederate who formed the first impression from the target's spontaneous behavior; in contrast, Facebook-based first impressions were made by 10 third-party raters according to the information posted on website pages. Given that the first impressions were made by different persons, it is unclear whether the same person would form the same impressions of a given target across the two contexts.

Though considerable research has suggested the capability of inferring some dimensions of the big-five traits in either real-world or virtual contexts, no research has been reported to explore the extent to which the same person could judge personality traits of the target/partner consistently across online and offline contexts. The insight into this issue will enrich our understanding of person perception across a wide scope of social interactions (involving daily conversation and online chatting) and provide empirical evidence for examining the theories of person perception, such as the realistic accuracy model (RAM, Funder, 2012) and the social relations lens model (Back et al., 2011).

Cue utilization in the processes of personality judgments

How do personality trait judgments occur? According to the model of interpersonal perception (Gosling et al., 2002; Vazire and Gosling, 2004), personality manifests in observable clues associated with individual identity and spontaneous behavior (including facial expressions). For example, some of the big-five personality traits are reflected in self-reported Facebook-related behavior and observable profile information (Gosling et al., 2011). Cues of physical environments (e.g., arrangements of offices and bedrooms; Gosling et al., 2002) and voice of greetings (McAleer et al., 2014) reveal what a person is like. The RAM suggests that perceivers are usually accurate in inferring a given trait when they utilize the available cues relevant to that trait (Funder, 2012). For instance, quick gaits (Thoresen et al., 2012) and frequencies of social activities posted on Facebook (Blackwell et al., 2017) enable the perceiver to make an accurate judgment of extraversion. The social relations lens model (Back et al., 2011) also confirms that observable cues displayed in social interaction allow person perception to happen.

Utilizable cues in real-world interaction usually consist of dynamically spontaneous behavior, facial expression, verbal information, and other non-verbal cues. By contrast, available cues presented on social media are in various forms, such as text-based information, pictures, videos, and combinations of two or more types (Wu et al., 2021). Informative cues are important for personality trait judgments. Pinpointing the ways by which people utilize various cues depending on the personalities judged across the online and offline environments will provide insight into understanding the processes of trait judgments (Wu et al., 2016b).

Current research

Empathy is composed of multiple dimensions, including state empathic concern and trait empathy (Zhao et al., 2019). The former is experienced as a momentary state elicited by various situations, while the latter pertaining to a relatively stable psychological disposition varies between people (Baron-Cohen and Wheelwright, 2004; Wu et al., 2016a). The empathic trait is referred to as the ability to understand the thinking and feelings of others and to behave appropriately (Baron-Cohen, 2012). In comparison with the big-five traits, empathic trait judgment has been paid little attention in the field of social perception. Prior research indicated that people are effective in detecting low and high levels of empathy (Wu et al., 2016a) and the big-five trait continua (Wu et al., 2017), but no evidence

has been reported if the same target would be judged similarly on these traits based on the real-world situations and the online settings.

The present research thus aimed to explore this issue, investigating the extent to which the same target would be formed a similar impression in terms of the big-five traits and the empathic trait across realistic and online communications. Specifically, participants were videoed when they have a 5-min structured conversation with the female experimenter on the topic of campus life. Later, they were paired with a person of the opposite gender to participate in a 10-min online text-based chatting on the same topic. Each participant was asked to infer the empathic trait and the big-five traits of the partner either after online chatting or after viewing the partner's conversation video (where they did not know the target was the same person as the online partner). They also reported the observable cues they drew upon in forming their impression in either context. Weisbuch et al. (2009) classified behavioral cues as non-verbal expressivity (e.g., lively vocal expression, smiling, open vs. closed smile, and facial expressivity) and verbal self-disclosure (e.g., revealing emotional information about the self, talking about oneself, and disclosing more than the partner) and categorized information in Facebook in terms of cues about social expressivity, a sociable interactive style, and self-disclosure. The present research focused on cues coded in the study of Weisbuch et al. but with a few modifications as detailed in the method section.

To summarize, this research was designed to examine the consistency in personality judgments between online chatting and offline conversation and to probe how the process occurs through associating observable cues with trait judgments. Given the previous evidence in the accuracy of personality judgments in real-world and virtual contexts, along with the consistency of first impressions on likability across spontaneous behavior and website pages, we hypothesized consistency in personality judgments of some traits regardless of accuracy. In addition, based on the model of interpersonal perception (Gosling et al., 2002; Vazire and Gosling, 2004) and research in the field of trait judgments (e.g., Back et al., 2011; Funder, 2012; Blackwell et al., 2017), we anticipated some cues observed either in spontaneous behavior or in online chatting would predominate in predicting trait judgments. Considering that self-report means (measurable with the inventory) of the big-five traits are generally the same as informant-report means (Kim et al., 2019), we adopted self-report means as the benchmark of accuracy. The consistency was indexed as the correlations of personality judgments relating to the same target between real-world conversation and online chatting. The study was consented by the research ethics committee of the university.

Method

Participants

A total of 174 college students (87 men, $M = 20.20$ years, SD = 1.22), randomly paired with the opposite gender (87 pairs), participated in the study. The sample size was prior determined following a calculation of G*Power 3.1 (Faul et al., 2009), offering a medium effect size ($\rho = 0.30$) with 95% statistical power to detect the bivariable correlations, and the sensitivity calculation with the sample size of 174 and 85% statistical power indicated an actual effect size of 0.26. The pairs of participants were previously unacquainted and had no opportunities to meet each other during the study, other than as arranged within the study.

Materials

Videos

A total of 174 video clips were developed as stimuli, in each of which the participant was having a 5-min structured conversation with the female experimenter, talking something about themselves on the topic of campus life. The videos included sound and were presented in a mean duration of 4.57 min (SD = 0.59, ranging from 2.48 to 5 min) with 1920×1080 pixels.

Empathy quotient

Participants filled in the empathy quotient (EQ) (Baron-Cohen and Wheelwright, 2004), which offers a comprehensive measurement of the trait structure of empathy. It comprises 40 items (along with 20 filter items) pertaining to a range of behaviors associated with empathizing, with an overall rating as the index of individual differences in the empathic trait. The range of the scores is 0–80. All targets completed the Chinese translated version of the EQ questionnaire (adapted from the website: https://www.autismresearchcentre.com/tests/empathy-quotient-eq-for-adults/). Cronbach's α is 0.85 in the present study.

The NEO Five-Factor Inventory-3

The NEO Five-Factor Inventory-3 (NEO-FFI-3) (Costa and McCrae, 2011) is used to measure the five trait dimensions of neuroticism (N), extraversion (E), openness to experience (O), agreeableness (A), and conscientiousness (C). Each of the 12 items, respectively, pertains to each of the five trait dimensions, with the response to each item on a 5-point Likert scale. The range of T scores of each trait is 25–75 (and above). Cronbach's α for the traits of N, E, O, A, and C is 0.85, 0.78, 0.61, 0.60, and 0.79, respectively, in this study.

Procedure

Video capture and personality measurements

In this phase, the participant individually completed the tasks for material collected in the laboratory. After signing a written consent form, they completed the EQ questionnaire and the NEO-FFI inventory in random order through the online questionnaire system Wen Juan Xing on a laptop. We calculated participants' self-ratings of the empathic trait

and the big-five traits on the inventories to measure their real personalities.

An iPhone 6 was previously prepared on a tripod, about 1.5 m away to record the participant's face and the top part of their body. Then, the participant proceeded to a 5-min structured conversation with the female experimenter who sat opposite to the participant but out of view of the camera; the conversation started with a 1-min self-introduction followed by a conversation with the experimenter on the topic of campus life (e.g., What major are you studying? What do you usually do in your spare time?). During the conversation, the participant was recorded without awareness. The cover story was they would be videoed when reading aloud a verbatim script of the screen test. After the conversation, the participant was asked to read verbatim texts of a joke in front of the camera when the experimenter ostensibly switched to "record mode." Finally, the participant posed a neutral expression for a passport-style picture while sitting on the chair in front of a white wall. The videos of reading the joke and the pictures were not used in the present research.

All participants were fully debriefed and gave written informed consent to use the videos and pictures for research purposes. Videos were edited using the software Jian Ying. Videos of the structured conversation in a duration less than 5 min were retained, and those in a duration more than 5 min were cropped from the beginning to 5 min.

Personality trait judgments

After 1 month of material collection, participants were paired with opposite genders at a different laboratory without any previous opportunity to meet each other. They were told their tasks were to do online chatting with an unfamiliar college student through texting, to view a video, and to fill in some questionnaires. After signing the consent form, they began with online texting for 10 min. The duration was determined by a pilot study with 26 participants (13 male participants) in which a 5-min online text-based chatting included limited information since they needed time to get to know each other. Specifically, they chatted with the partner on the topic of campus life by messaging each other on uniquely created WeChat accounts. The participants were asked not to reveal personal information (e.g., names, majors, and departments) during the chatting. Using the new accounts instead of the real WeChat accounts of the participants ensured that personality judgments were made according to online chatting rather than archived profile information.

After the chatting, the experimenter provided the information sheet of the empathic trait and the big-five traits which defined different traits, and offered an explanation of the scales (including the score ranges) of each trait based on the inventory manuals (0–80 for empathy and 25–75 for the T scores of each big-five trait dimension). Once the participants confirmed understanding the information sheet, they proceeded to the task of making personality trait judgments about the partner. The orders of the judgments about the empathic trait and the big-five traits were counterbalanced across participants, and the orders of the big-five trait judgments followed the fixed order of N, E, O, A, and C. To avoid participants anchoring their own personality ratings on the target, we adopted the continuous scales instead of the other-report inventories as the response options, that is, the participant was required to infer each partner trait by judging the trait scores using a continuous scale ranging from the lower limit to the upper limit of the scores corresponding to the trait in the inventory (i.e., 0–80 for empathy and 25–75 for the big-five traits). In addition, the participant evaluated their confidence in each trait judgment (from 0 to 100%). After completing the task of personality judgments, the participants were asked to evaluate the observable cues about the partner, with each cue presented in terms of a question that required the participant to respond on a 7-point Likert scale (details appear in the Results in the Supplementary material).

To ensure completing the same tasks synchronously by the pair of participants and to prevent being influenced by the contents of the conversation, all participants proceeded to judge the personalities of the target in the video-based conversation after the online chatting rather than in a counterbalanced order of the two contexts. Specifically, after a short break, the participant was instructed to view the partner's video in the structured conversation with the experimenter. The participant did not know the person in the video was the partner with whom they had chatted on WeChat. After watching the video, similar to the procedure in the online chatting, the participant read the information sheet and then proceeded to judge the traits of the target together with reporting their judgmental confidence. Subsequently, the participants were asked to evaluate the observable cues about the target, with each cue presented in terms of a question that required the participant to respond on a 7-point Likert scale (details appear in the Results in the Supplementary material). No participants doubted that the partner in the online chatting was the same target in the conversation video.

Results

Accuracy in personality trait judgments

To examine whether participants were able to detect the target trait in each of the contexts, Pearson's correlations were conducted between the self-reported personality traits and the corresponding trait ratings in the online chatting and the conversation contexts, respectively. Table 1 shows the coefficients of the Pearson correlations, along with the corresponding partial correlations controlled for the judgmental confidences (the mean judgments of each trait and the corresponding mean judgmental confidence in each context are demonstrated in Supplementary Table S1). According to Table 1, there were only significant correlations between the self-reported target E and the E rated in the online chatting ($r = 0.16$, $p = 0.034$) and the E rated in the conversation ($r = 0.42$, $p < 0.001$), and between the self-reported target N and the N assessed in the conversation ($r = 0.16$, $p = 0.039$). The results were sustained after controlling for the judgmental confidence of each trait. Overall, participants were able to detect the trait of E either in the online chatting or the offline conversation and were somewhat accurate in judging the trait of N in the conversation; but they failed to make accurate judgments on the other traits in both contexts.

TABLE 1 Coefficients (and *p*) of Pearson's correlations between self-reported personality traits and the judgments of each trait in each context, and the corresponding partial correlations controlled for the judgmental confidences, along with the 95% confidence interval of each correlation ($N = 174$).

Traits	Pearson correlations		Partial correlations	
	Online chatting	Conversation	Online chatting	Conversation
Empathy	0.14 (0.074) [0, 0.26]	−0.03 (0.736) [−0.17, 0.10]	0.14 (0.070) [0, 0.27]	−0.01 (0.932) [−0.15, 0.14]
N	0.01 (0.884) [−0.014, 0.17]	0.16 (**0.039**) [0.01, 0.32]	0.01 (0.889) [−0.14, 0.16]	0.16 (**0.038**) [0.0.31]
E	0.16 (**0.034**) [0.01, 0.31]	0.42 (**<0.001**) [0.29, 0.53]	0.17 (**0.024**) [0.02, 0.31]	0.43 (**<0.001**) [0.32, 0.54]
O	−0.10 (0.177) [−0.24, 0.04]	0.05 (0.527) [−0.10, 0.21]	−0.14 (0.075) [−0.29, 0.01]	0.06 (0.474) [−0.12, 0.21]
A	−0.01 (0.899) [−0.15, 0.13]	0 (0.971) [−0.15, 0.15]	−0.05 (0.479) [−0.20, 0.10]	0 (0.967) [−0.16, 0.15]
C	0.14 (0.063) [0, 0.27]	0.10 (0.214) [−0.04, 0.23]	0.13 (0.084) [−0.02, 0.26]	0.10 (0.186) [-0.05, 0.24]

The bold values correspond to the significant *p* values.

TABLE 2 Coefficients of Pearson's correlations between the mean judgments of each trait and the mean rating of each cue (cue utilization) and between the mean self-reported rating of each trait and the mean rating of each cue (cue validity) in the online chatting context ($N = 174$).

Cue utilization						Cues	Cue validity					
Empathy	N	E	O	A	C		Empathy	N	E	O	A	C
0.25***	0.06	0.46***	0.34***	0.18*	0.11	Contents	−0.06	−0.05	0.12	0.01	0.03	0.10
−0.08	0.01	−0.11	−0.16*	0	−0.07	Self-disclosure	−0.04	−0.07	0.03	0.02	0.02	−0.03
0.12	−0.05	0.33***	0.21**	0.11	0.11	Talking about self	0.03	−0.01	0.07	0.06	−0.05	0.05
0.23**	0.04	0.43***	0.28***	0.23**	0.13	Being active	−0.03	−0.19*	0.24**	−0.05	0.12	0.19*
0.40***	0.11	0.42***	0.31***	0.14	0.19*	Verbal skills	−0.02	−0.06	0.09	−0.03	0.05	0.12
0.27***	−0.01	0.30***	0.20**	0.06	0.01	Common interests	−0.10	−0.07	0.07	−0.05	0.06	0.03
0.21**	0.01	0.27***	0.10	0.13	0.12	Immediate reply	−0.03	−0.10	0.16*	−0.10	0.02	0.06
0.38***	0.17*	0.40***	0.32***	0.20**	0.07	Interesting	−0.17*	−0.01	0.01	−0.02	−0.03	0.02
−0.08	0.09	−0.29***	−0.13	−0.11	−0.05	Waiting for responses	−0.01	0.11	−0.03	0.15*	0	−0.01
−0.05	0.02	−0.19**	−0.05	−0.15	0	Using emoticons	−0.04	0	0.02	−0.07	−0.02	0.09

*$p < 0.05$.
**$p \leq 0.01$.
***$p \leq 0.001$.

Consistency in personality trait judgments across the online chatting and the offline conversation

Pearson's correlations for each trait judgment were carried out to examine the consistency between the online chatting and the offline conversation. The results suggested consistent judgments on each trait across the two contexts [Empathy: $r = 0.29$, $ICs = (0.13, 0.43)$, $p < 0.001$; N: $r = 0.33$, $ICs = (0.19, 0.47)$, $p < 0.001$; E: $r = 0.25$, $ICs = (0.12, 0.40)$, $p = 0.001$; O: $r = 0.23$, $ICs = (0.10, 0.37)$, $p = 0.002$; A: $r = 0.28$, $ICs = (0.11, 0.42)$, $p < 0.001$; C: $r = 0.30$, $ICs = (0.12, 0.47)$, $p < 0.001$]. When the self-reported trait ratings were partialed out, the correlations survived [Empathy: $r = 0.29$, $ICs = (0.13, 0.45)$, $p < 0.001$; N: $r = 0.34$, $ICs = (0.19, 0.47)$, $p < 0.001$; E: $r = 0.21$, $ICs = (0.05, 0.36)$, $p = 0.006$; O: $r = 0.24$, $ICs = (0.10, 0.37)$, $p = 0.002$; A: $r = 0.28$, $ICs = (0.11, 0.42)$, $p < 0.001$; C: $r = 0.29$, $ICs = (0.10, 0.46)$, $p < 0.001$]. In short, the target was estimated similarly on their traits regardless of accuracy across the online chatting and the realistic conversation.

Cue utilization and cue validity in personality trait judgments

We examined the cues utilized when participants made judgments of each trait by calculating the correlations between the mean estimation of each trait and the mean rating of each cue and examined the valid cues by computing the correlations between the mean self-reported rating of each trait and the mean

TABLE 3 Coefficients of Pearson's correlations between the mean judgments of each trait and the mean rating of each cue (cue utilization) and between the mean self-reported rating of each trait and the mean rating of each cue (cue validity) in the offline conversation context ($N = 174$).

Cue utilization						Cues	Cue validity					
Empathy	N	E	O	A	C		Empathy	N	E	O	A	C
0.36***	0.06	0.43***	0.40***	0.37***	0.34***	Contents	−0.03	−0.15*	0.26**	0.02	0.03	0.14
0.43***	0.04	0.52***	0.46***	0.26***	0.35***	Being active	−0.10	−0.19*	0.32***	0.05	0.08	0.22**
0.33***	0.05	0.38***	0.38***	0.29***	0.38***	Verbal skills	−0.20**	−0.15*	0.18*	0.05	0	0.08
0.31***	−0.07	0.43***	0.40***	0.26***	0.27***	Facial expression	−0.14	−0.26***	0.27***	0.10	0.08	0.20**
0.17*	0.01	0.17*	0.23**	0.33***	0.22**	Gaze attention	0.02	−0.02	0.09	−0.05	0.03	0.12
0.12	0	0.16*	0.20**	−0.01	0.16*	Bodily movements	0.07	0.04	0.13	−0.03	0.02	−0.05
0.12	−0.03	0.28***	0.23**	0.11	0.11	Smiling/laughing	−0.18*	−0.08	0.20**	0.04	−0.01	0.04
0.21**	0.085	0.35***	0.34***	0.20**	0.31***	Speaking speed	−0.19*	0	0.11	−0.02	−0.08	0
0.29***	−0.07	0.48***	0.44***	0.22**	0.38***	Confidence in talking	−0.02	−0.21**	0.34***	0.02	0.06	0.23**
0.34***	−0.03	0.39***	0.37***	0.28***	0.30***	Pleasure in talking	−0.11	−0.14	0.26***	−0.02	0.11	0.09
0	0.03	−0.08	−0.12	−0.08	−0.04	Self-disclosure	0.03	−0.11	−0.01	0.08	0.06	0.08
0.14	0.03	0.11	0.06	0.06	0.04	Talking about self	−0.16*	0.02	−0.06	−0.01	−0.15*	0.01

*$p < 0.05$.
**$p \leq 0.01$.
***$p \leq 0.001$.

ratings of each cue (all data were transformed into Fisher's Z scores before calculating the correlations). Tables 2, 3 report the cue utilization and cue validity in the online chatting and the offline conversation contexts, respectively (the mean evaluations of each cue in each context are presented in Supplementary Table 2). As demonstrated in Tables 2, 3 ("cue utilization"), participants employed various cues while making trait judgments either in the online chatting or in the offline conversion, and they generally utilized more cues in the conversation than in the online chatting. For example, though few cues were utilized to judge trait N in both contexts, there were much more cues used in judging traits A and C in the realistic conversation than in the online chatting. In addition, considerable cues were adopted when judging the trait E in either context, and which cues were employed more or less depending on which of the traits was judged.

By contrast, there were few cues valid in the online chatting context and limited cues valid in the offline conversation (seeing "cue validity" shown in Tables 2, 3). Specifically, in the online chatting, the self-reported N was merely negatively associated with the mean frequencies of being active, and the self-reported E was correlated only with the cues of being active and immediate replay. In the conversation context, the self-reported empathy, N, E, and C were, respectively, correlated with several cues, with more cues in E.

To probe which of the cues predicted trait judgments in each context, we conducted a linear regression analysis for each trait (except for N) and the significantly associated cues, with the trait judgments as the dependent variable and the cues as the independent variables. Table 4 displays the results demonstrating significant predictive cues. In the online chatting, the cues of verbal skills and being interesting predicted estimations of empathic traits; the frequencies of using emoticons served as the predictors in the judgments of E. There were no specific cues predicting the judgments of O, A, and C. In the offline conversation, being active was predictive for judgments of empathic trait; being active and speaking speed functioned to predict the judgments of E; speaking speed and frequencies of bodily movements predicted the judgments of O; valences of conversation contents and frequencies of gaze attention were predictive for the inferences of A, and verbal skills predicted the judgments of C.

Discussion

Past research provides considerable evidence for accuracy in judging strangers' personality traits in either realistic contexts (e.g., Back and Nestler, 2016) or in virtual environments (e.g., Azucar et al., 2018). The present research originally explored the consistency in personality trait judgments across realistic and virtual contexts, contributing to the literature by adding evidence in our ability to perceive the same person consistently in the aspects of empathy and the big-five traits across online and offline social interactions. Moreover, the study demonstrated the processes by which people utilized various cues while making personality trait judgments in realistic and virtual contexts, which enriches the theories of social perception,

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TABLE 4 Summaries of the liner regression analyses between each trait and the corresponding correlated cues.

IV	Unstandardized *B*	SE	*p*-value	95% CIs of *B*	*β*
Online chatting					
DV: Empathy estimations, final model: Adjusted $R^2 = 0.18$, SE of the estimate = 11.44, $p < 0.001$, $N = 174$					
Constant	25.93	5.20	**<0.001**	[15.66, 36.21]	–
Verbal skills	3.19	1.06	**0.003**	[1.10, 5.27]	0.27
Interesting	2.15	0.79	**0.038**	[0.10, 3.42]	0.19
DV: Estimations of E, final model: Adjusted $R^2 = 0.31$, SE of the estimate = 9.79, $p < 0.001$, $N = 174$					
Constant	30.38	5.78	**<0.001**	[18.96, 41.79]	–
using emoticons	−0.92	0.47	**0.049**	[−1.84, 0]	−0.13
Offline conversation					
DV: Empathy estimations, final model: Adjusted $R^2 = 0.18$, SE of the estimate = 11.97, $p < 0.001$, $N = 174$					
Constant	23.24	5.94	**<0.001**	[11.51, 34.97]	–
Being active	2.67	0.94	**0.005**	[0.81, 4.52]	0.30
DV: Estimations of E, final model: Adjusted $R^2 = 0.32$, SE of the estimate =10.29, $p < 0.001$, $N = 174$					
Constant	18,76	5.29	**0.001**	[8.30, 29.21]	–
Being active	2.35	0.81	**0.004**	[0.75, 3.94]	0.28
Speaking speed	2.36	1.06	**0.028**	[0.26, 4.45]	0.17
DV: Estimations of O, final model: Adjusted $R^2 = 0.27$, SE of the estimate = 8.67, $p < 0.001$, $N = 174$					
Constant	23.92	4.46	**<0.001**	[15.12, 32.72]	–
Speaking speed	1.89	0.89	**0.035**	[0.13, 3.66]	0.16
Frequencies of bodily movements	0.83	0.40	**0.038**	[0.04, 1.61]	0.15
DV: Estimations of A, final model: Adjusted $R^2 = 0.17$, SE of the estimate = 7.56, $p < 0.001$, $N = 174$					
Constant	37.99	3.75	**<0.001**	[30.58, 45.40]	–
Content valences	2.44	0.80	**0.003**	[0.87, 4.01]	0.33
Gaze attention	1.06	0.41	**0.011**	[0.25, 1.86]	0.20
DV: Estimations of C, final model: Adjusted $R^2 = 0.20$, SE of the estimate = 8.98, $p < 0.001$, $N = 174$					
Constant	29.42	4.53	**<0.001**	[20.46, 38.37]	–
Verbal skills	2.07	0.80	**0.010**	[0.50, 3.64]	0.25

The bold values correspond to the significant *p* values.

such as the realistic accuracy model (Funder, 2012) and the social relations lens model (Back et al., 2011). These theories are insightful in explaining the ways by which people perceive personality traits of each other by using observable cues in face-to-face interactions, whereas the current study extends the interpretive robustness into trait judgments that occur in online settings.

Accuracy and cue validity in personality trait judgments across online chatting and offline conversation

This research is the first empirical work examining the consistency in personality trait inferences across realistic conversation and online text-based chatting (through social media WeChat), and probing the process of trait inferences on the basis of observable cues in the two contexts. The findings replicate previous reports on personality judgments in either the real world (e.g., Carney et al., 2007; Thoresen et al., 2012; Back and Nestler, 2016) or online contexts (e.g., Markey and Wells, 2002; Marshall et al., 2015; Blackwell et al., 2017), suggesting that people were accurate in detecting the trait of E. The trait E is revealed in behavioral cues. For example, extroverted people are inclined to speak loudly, which demonstrates social skills and more bodily expressions (Funder and Sneed, 1993); they also publish more social activities on social media (e.g., Blackwell et al., 2017).

According to the RAM, accuracy in trait judgments usually occurs when cues relevant to the trait are available (Funder, 2012). Our data suggested several valid cues reflecting target self-reported trait E, such as the cues of being active and frequencies of immediate reply in the online chatting, and the valence of talking contents, facial expression, being active, verbal skills, and so on in

the context of the conversation (seeing Tables 2, 3). These cues were also pertaining to participants' judgments of the trait E (regardless of accuracy), some of which served to predict the judgments of E in the two contexts. In line with the RAM, when cues relevant and available to a certain trait are appropriately utilized, people are usually able to make accurate judgments on that trait.

Though the "inner trait" N is usually unperceivable from the observable cues (Vazire, 2010; Funder, 2012), participants in this study were accurate in judging N when observing the target in the offline conversation. Several cues, such as being active, the valences of talking contents, and facial expression, were negatively associated with the self-reported rating of N; however, participants seemed not to utilize the given cues to make judgments of N. Hence, the study might not capture the valid cues participants might have employed to make an accurate judgment about N in the conversation.

Despite various cues utilized in judging the other big-five traits in both contexts, there were very limited cues valid. For instance, no cues for the self-reported assessment of O were available in the conversation, and none of the cues for the self-reported assessment of A were observed in the online chatting. Although there were some cues pertaining to the self-reported C in the conversation, they did not include the cues of verbal skills which predicted the judgments of C. According to the RAM (Funder, 2012), it seems reasonable that participants found it hard to accurately judge these traits due to a lack of valid cues. Interestingly, though the cues including verbal skills, speaking speed, frequencies of smiling/laughing, and frequencies of talking about self were negatively associated with the self-reported empathic traits, these cues (except for frequencies of smiling/laughing and talking about self) were positively correlated with the judgments of empathy. According to the RAM (Funder, 2012), the cues might not be interpreted in an appropriate way; as a result, they were not informative in making an accurate judgment of empathy.

Consistency and cue utilization in personality trait judgments across online chatting and offline conversation

Consistency was defined as the correlations in personality judgments about the same target between the online chatting and the offline conversation. There were significant consistencies in the judgments about empathic and big-five traits across the two contexts regardless of judgmental accuracy. In other words, if a person was adjudged to be an extrovert in WeChat chatting, then it was likely the person would also be adjudged extrovert in the offline conversation. Past research suggests people make use of behavioral cues in real-world situations (e.g., Borkenau et al., 2004, 2009) or "digital footprints" in virtual environments (Azucar et al., 2018) judging the big-five traits. Weisbuch et al. (2009) originally bridged the real-world context with the online environment to investigate the consistency in first impression formation, revealing that a person who was liked in a real-world conversation was also liked on Facebook. The current study extends the evidence of consistency in trait judgments about the same person across traditional conversation and text-based online chatting in terms of empathic and big-five traits. It provided a creative methodology for exploring consistent first impressions in personality traits in an extensive scope of contexts. Nowadays, people interact with each other not only in the traditional face-to-face ways but also through various social media, and thus, it is meaningful to know the extent to which we can make similar trait judgments about the same person across real and virtual environments, and how these judgments happen. The present study contributed to the insights into these issues.

Why did people make consistent trait judgments about the same person across real and virtual contexts? On the one hand, personality traits, as a stable psychological structure, are relatively consistent over time and across situations (Funder, 2006). Actual personalities can be leaked out in spontaneous behavior (e.g., Carney et al., 2007; Funder, 2012; Biesanz, 2014; Wu et al., 2016a,b, 2017) and can be traced from a variety of online information (Vazire and Gosling, 2004; Back et al., 2010; Wu et al., 2021), such as status updates (e.g., Gosling et al., 2011), online social activities postings (Blackwell et al., 2017), and profile pictures (Liu et al., 2016). The same target would more or less anchor his/her actual personality in multiple cues when having a conversation with the experimenter or when doing a text-based online chatting with the partner. On the other hand, research has revealed that people behave consistently across different social situations (Funder and Colvin, 1991). In the present research, participants utilized many cues when making judgments of each trait (except for N) in both online chatting and offline conversation. Some cues were predictive in judging a particular trait, that is, the utilization of the observable cues in both contexts enabled consistent judgments of the same trait about the same person.

The present research directly compared cues observed from the same person in both online chatting and offline conversation contexts when making personality trait judgments. These not only provide evidence for the correspondence between personality trait judgments of the same person across the two environments but also probe the processes by which participants made use of multiple observable cues to infer each of the traits.

Different from the research from Weisbuch et al. (2009) which compared spontaneous behavior with the information abstracted from the website pages, the present research constrained the contexts to social interaction, occurring either in the real world or on social media. Ongoing behavior (e.g., facial expressions, verbal contents, and bodily movements) in traditional conversation is dynamic and fleeting (Wu et al., 2021), whereas cues in text-based online chatting are presented in static patterns (such as texts and emoticons) that can be repeatedly reviewed. The data showed cues from the real-world conversation were much richer than those from online chatting. Even so, participants were able to make consistent trait judgments across the two contexts, suggesting that different types of cues were observed and employed when making judgments of personality traits. Nonetheless, participants were generally more confident in their trait judgments when observing the target in the conversation than when chatting with them online (relevant data analyses appeared in the Supplementary material).

Participants made use of various cues in judging the personality traits of strangers no matter whether the judgments were accurate. In other words, people might be driven to explain observable information and the behavior of others for understanding others' psychological dispositions (Wu et al., 2019). They base their personality trait judgments on something available about the target, which makes them feel reasonable about their behavior (embodied in personality judgments). Nonetheless, how the cues are utilized during personality judgments depends on different traits. Participants did not indiscriminately draw upon all available cues to judge each trait in the online chatting or the conversation. For instance, in the offline conversation, the cue of being active in the talking predicted participant judgments about the empathic trait, whereas the cues of verbal skills predicted the judgments of trait C.

Limitations and future research

Given that the participants judged each other on the personality traits during the dyadic online interaction or based on viewing the partner in a dyadic conversation, the research involves interdependent data that might be influenced by the potential covariance (Gonzalez and Griffin, 2012), such as following the general opinion about others when ascribing personality traits to each other. This possibility cannot be completely excluded, though we did the partial correlations by controlling self-reported assessments of each trait when calculating the consistencies of each trait rating across the online and offline settings. Hence, future research can adjust the experimental design by asking each participant to, respectively, interact with two partners in the online setting and then meet and interact with one of the online chatting partners and with a new partner in real-life contexts. In this way, it would provide a direct examination of the difference with which the participants evaluate the same person compared to a person who actually has different characteristics. If the high correlation is only observed when the partner was the same rather than when the partner is a different person, then the consistency in the present research would be robust and corroborated.

Conclusion

Despite that people were not good at inferring empathic traits and most dimensions of the big-five traits while having a brief texted-based online chat or observing the partner in a real-world conversation for several minutes, they formed pretty consistent first impressions of empathy and the big-five traits on each other across the virtual and realistic social contexts. Few valid cues were associated with targets' real personality traits, which makes it difficult to accurately judge most traits except for the trait E which was signaled in several cues in online and offline communications. Nevertheless, people did make use of quite a few cues while judging the partner during online chatting or viewing the partner in the face-to-face conversation, and which cues were utilized depending on which trait was judged. Furthermore, more cues were employed in the offline conversation than in the online chatting while making judgments of each trait, and some cues served to predict the judgments of some traits. In conclusion, the present research provided an original empirical examination of consistency in trait judgments across online chatting and offline conversation and illuminated the process by which people made use of various cues in judging each of the traits. The research adds insight into social perception in real-world and virtual social interactions, reflecting our capability in perceiving others (even strangers) consistently.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: https://doi.org/10.6084/m9.figshare.22321432.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of Lingnan Normal University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

WW contributed to the conceptualization, methodology, data analyses, writing, and reviewing the original draft. PM contributed to reviewing the draft. YL contributed to data collection and data analyses. All authors contributed to the article and approved the submitted version.

Funding

The authors are grateful for the financial support of the National Natural Science Foundation of China (No. 31900782) awarded to the WW.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyg.2023.1077458/full#supplementary-material

References

Azucar, D., Marengo, D., and Settanni, M. (2018). Predicting the Big 5 personality traits from digital footprints on social media: a meta-analysis. *Pers. Individ. Dif.* 124, 150–159. doi: 10.1016/j.paid.2017.12.018

Back, M., Schmukle, S., and Egloff, B. (2011). A closer look at first sight: social relations lens model analysis of personality and interpersonal attraction at zero acquaintance, *Eur. J. Personal.* 25, 225–238. doi: 10.1002/per.790

Back, M. D., and Nestler, S. (2016). "Judging personality," in *The Social Psychology of Perceiving Others Accurately*, eds J. A. Hall, M. Schmidt Mast, and T. V. West (Cambridge: Cambridge University Press), 98–124. doi: 10.1017/CBO9781316181959.005

Back, M. D., Stopfer, J. M., Vazire, S., Gaddis, S., Schmukle, S. C., Egloff, B., and Gosling, S. D (2010). Facebook profiles reflect actual personality, not self- idealization. *Psychol. Sci.* 21, 372–374. doi: 10.1177/0956797609360756

Baron-Cohen, S. (2012). *Zero Degrees of Empathy: A New Theory of Human Cruelty and Kindness*. London, Penguin Books.

Baron-Cohen, S., and Wheelwright, S. (2004). The empathy quotient: an investigation of adults with asperger syndrome or high functioning autism, and normal sex differences. *J. Autism Dev. Disord.* 34, 163–175. doi: 10.1023/B:JADD.0000022607.19833.00

Biesanz, C. J. (2014). The social accuracy model of interpersonal perception: assessing individual differences in perceptive and expressive accuracy. *Multivariate Behav. Res.* 45, 853–885. doi: 10.1080/00273171.2010.519262

Blackwell, D., Leaman, C., Tramposch, R., Osborne, C., and Liss, M. (2017). Extraversion, neuroticism, attachment style and fear of missing out as predictors of social media use and addiction. *Pers. Individ. Dif.* 116, 69–72. doi: 10.1016/j.paid.2017.04.039

Borkenau, P., Brecke, S., Möttig, C., and Paelecke, M. (2009). Extraversion is accurately perceived after a 50-ms exposure to a face. *J. Res. Pers.* 43, 703–706. doi: 10.1016/j.jrp.2009.03.007

Borkenau, P., Mauer, N., Riemann, R., Spinath, F., and Angleitner, A. (2004). Thin slices of behavior as cues of personality and intelligence. *J. Pers. Soc. Psychol.* 86, 599–614. doi: 10.1037/0022-3514.86.4.599

Carney, D. R., Colvin, C. R., and Hall, J. A. (2007). A thin slice perspective on the accuracy of first impressions. *J. Res. Pers.* 41, 1054–1072. doi: 10.1016/j.jrp.2007.01.004

Costa, P. T., and McCrae, R. R. (2011). *NEOTM Inventories: NEOTM Personality Inventory-3 (NEOTM-PI-3) Manual*. Lutz, FL: Psycho- logical Assessment Resources, Inc.

Faul, F., Erdfelder, E., Buchner, A., and Lang, A. G. (2009). Statistical power analyses using G*power 3.1: tests for correlation and regression analyses. *Behav. Res. Methods* 41, 1149–1160. doi: 10.3758/BRM.41.4.1149

Funder, D. C. (2006). Towards a resolution of the personality triad: persons, situations, and behaviors. *J. Res. Pers.* 40, 21–34. doi: 10.1016/j.jrp.2005.08.003

Funder, D. C. (2012). Accurate personality judgment. *Curr. Dir. Psychol. Sci.* 21, 177–182. doi: 10.1177/0963721412445309

Funder, D. C., and Colvin, C. R. (1991). Explorations in behavioral consistency: properties of persons, situations, and behaviors. *J. Pers. Soc. Psychol.* 60, 773–794. doi: 10.1037/0022-3514.60.5.773

Funder, D. C., and Sneed, C. D. (1993). Behavioral manifestations of personality: an ecological approach to judgmental accuracy. *J. Pers. Soc. Psychol.* 64, 479–490. doi: 10.1037/0022-3514.64.3.479

Gonzalez, R., and Griffin, D. (2012). "Dyadic data analysis," in *APA Handbook of Research Methods in Psychology*, ed H. Cooper, Vol. 3. Data Analysis and Research Publication (Washington, DC: American Psychological Association), 439–450. doi: 10.1037/13621-022

Gosling, S. D., Augustine, A. A., Vazire, S., Holtzman, N., and Gaddis, S. (2011). Manifestations of personality in online social networks: self-reported Facebook-related behaviors and observable profile information. *Cyberpsychol. Behav. Soc. Netw.* 14, 483–488. doi: 10.1089/cyber.2010.0087

Gosling, S. D., Ko, S. J., Mannarelli, T., and Morris, M. E. (2002). A room with a cue: personality judgments based on offices and bedrooms. *J. Pers. Soc. Psychol.* 83, 379–398. doi: 10.1037/0022-3514.82.3.379

Kim, H., Di Domenico, S. I., and Connelly, B. S. (2019). Self-other agreement in personality reports: a meta-analytic comparison of self- and informant-report means. *Psychol. Sci.* 30, 129–138. doi: 10.1177/0956797618810000

Lee, E., Ahn, J. Kim, Y. J. (2014). Personality traits and self-presentation at Facebook. *Pers. Individ. Differ.* 69, 162–167. doi: 10.1016/j.paid.2014.05.020

Liu, L., Preotiuc-Pietro, D., Samani, Z. R., Moghaddam, M. E., and Ungar, L. H. (2016). Analyzing personality through social media profile picture choice. ICWSM 10, 211–220. doi: 10.1609/icwsm.v10i1.14738

Marcus, B., Machilek, F., and Schütz, A. (2006). Personality in cyberspace: personal web sites as media for personality expressions and impressions. *J. Pers. Soc. Psychol.* 90, 1014–1031. doi: 10.1037/0022-3514.90.6.1014

Markey, P. M., and Wells, S. M. (2002). Interpersonal perception in internet chat rooms. *J. Res. Pers.* 36, 134–146. doi: 10.1006/jrpe.2002.2340

Marshall, T. C., Lefringhausen, K., Ferenczi, N. (2015). The Big Five, self-esteem, and narcissism as predictors of the topics people write about in Facebook status updates. *Pers. Individ. Differ.* 85, 35–40. doi: 10.1016/j.paid.2015.04.039

McAleer, P., Todorov, A., and Belin, P. (2014). How do you say "hello"? Personality impressions from brief novel voices. *PLoS ONE* 9, e90779. doi: 10.1371/journal.pone.0090779

Thoresen, J. C., Vuong, Q. C., and Atkinson, A. P. (2012). First impressions: gait cues drive reliable trait judgments. *Cognition* 124, 261–271. doi: 10.1016/j.cognition.2012.05.018

Tskhay, K. O., and Rule, N. O. (2014). Perceptions of personality in text-based media and OSN: a meta-analysis. *J. Res. Pers.* 49, 25–30. doi: 10.1016/j.jrp.2013.12.004

Vazire, S. (2010). Who knows what about a person? The self-other knowledge asymmetry (SOKA) model. *J. Pers. Soc. Psychol.* 98, 281–300. doi: 10.1037/a0017908

Vazire, S., and Gosling, S. D. (2004). E-perceptions: personality impressions based on personal websites. *J. Pers. Soc. Psychol.* 87, 123–132. doi: 10.1037/0022-3514.87.1.123

Weisbuch, M., Ivcevic, Z., and Ambady, N. (2009). On being liked on the web and in the "real world": consistency in first impressions across personal webpages and spontaneous behavior. *J. Exp. Soc. Psychol.* 45, 573–576. doi: 10.1016/j.jesp.2008.12.009

Wu, W., Mitchell, P., Zheng, J., and Chen, S. (2021). Accuracy in trait judgments based on WeChat: detecting who stands on the extreme levels of the big-five trait continua. *Pers. Individ. Dif.* 173, 110610. doi: 10.1016/j.paid.2020.110610

Wu, W., Sheppard, E., and Mitchell, P. (2016a). Being sherlock holmes: can we sense empathy from a brief sample of behavior? *Br. J. Psychol.* 107, 1–22. doi: 10.1111/bjop.12157

Wu, W., Sheppard, E., and Mitchell, P. (2016b). The game is afoot: a response to three insightful commentaries. *Br. J. Psychol.* 107, 33–35. doi: 10.1111/bjop.12168

Wu, W., Sheppard, E., and Mitchell, P. (2017). Judging personality from a brief sample of behavior: it is relatively easy to detect who is unique on a trait. *Eur. J. Pers.* 31, 685–700. doi: 10.1002/per.2116

Wu, W. Sheppard, E., and Mitchell, P. (2019). Interpreting signals in other people's behavior to sense things about them and to infer things about their world. *Soc. Personal. Psychol. Compass* 13, e12513. doi: 10.1111/spc3.12513

Zhao, X., Li, X., Song Y., and Shi, W. (2019). Autistic traits and prosocial behavior in the general population: test of the mediating effects of trait empathy and state empathic concern. *J. Autism Dev. Disord.* 49, 3925–3938. doi: 10.1007/s10803-018-3745-0

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 09 May 2023
DOI 10.3389/fpsyg.2023.1138469

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OPEN ACCESS

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RECEIVED 05 January 2023
ACCEPTED 20 April 2023
PUBLISHED 09 May 2023

CITATION
Xing Z, Guo K, Hui Z and Ma Q (2023) Exercise adherence and suicidal ideation of Chinese college students: a chain mediation model test. *Front. Psychol.* 14:1138469. doi: 10.3389/fpsyg.2023.1138469

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Exercise adherence and suicidal ideation of Chinese college students: a chain mediation model test

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Objective: The purpose of this study was to explore the relationship between exercise adherence and suicidal ideation in college students, as well as the mediating role of meaning in life and internet addiction.

Methods: A total of 1925 college students (M_{age}=19.51years, SD_{age}=2.393years) were recruited by stratified cluster sampling method in Zhaoqing University, among which 890 were males and 1,035 were females. Exercise adherence, meaning in life, internet addiction and suicidal ideation were assessed by using standard scales. Data were analyzed by Pearson Correlation Analysis, and bias-correction percentile Bootstrap method.

Results: (1) There is a significant correlation between exercise adherence, meaning in life, internet addiction and suicide ideation; (2) meaning in life plays a significant mediating role between exercise adherence and suicidal ideation; internet addiction plays a significant mediating role between exercise adherence and suicidal ideation; meaning in life and internet addiction play a chain mediating role between exercise adherence and suicide ideation.

Conclusion: Exercise adherence can not only directly predict college students' suicidal ideation, but also indirectly predict college students' suicidal ideation through the independent mediation and chain mediation of meaning in life and internet addiction.

KEYWORDS

exercise persistence, meaning in life, internet addiction, suicidal ideation, college student

Introduction

Suicide has become an important public health problem around the world (Wang et al., 2019), it is the primary cause of abnormal death among Chinese college students, and their suicide rate is 2–4 times that of the normal population (Liu et al., 2014). An American mental health institute divides suicidal behavior into three steps, namely, suicidal ideation, suicide attempt and suicide death (Shang et al., 2008), among them, suicidal ideation is the first step to commit suicidal behavior, which can accurately predict suicidal behavior (Chao, 2018). Suicide ideation refers to the idea or motive of ending one's own life that an individual experiences accidentally. It plays an important role in predicting suicide plan and suicide attempt, and it is also the inevitable psychological activity of suicide death in the early stage (Liu and Wang, 2019).

Studies have shown that exercise adherence can negatively predict suicidal ideation in college students (Gao and Ren, 2019). Therefore, this study explores the relationship between exercise adherence and suicidal ideation in college students, and also explores whether meaning in life and internet addiction have mediating effects between them, so as to provide theoretical guidance for the prevention of suicide in college students by improving exercise adherence.

Exercise adherence and suicidal ideation

Exercise adherence refers to the extent to which an individual can effectively achieve a predetermined exercise plan during physical exercise (Wang et al., 2018). Studies have shown that exercise adherence is negatively correlated with suicidal ideation in college students (Brown, 2005; Lei et al., 2021), and exercise adherence can negatively predict suicidal ideation (Wei, 2018). College students with high exercise adherence have lower probability of suicidal ideation (Wang et al., 2022), on the contrary, college students with low exercise adherence had a higher probability of suicidal ideation (Mirim et al., 2008). A longitudinal study has shown that exercise adherence is an important factor in reducing suicidal ideation in college students, and improving exercise adherence can reduce suicidal ideation (Wei and Yang, 2020). Therefore, we propose the following hypothesis:

> *Hypothesis 1*: exercise adherence can significantly negatively predict college students' suicidal ideation.

The mediating role of meaning in life

Meaning in life refers to the individual's feeling of life and the individual's view on the purpose, direction and attitude of life. It is a kind of high-level psychological feeling, including two independent and complementary dimensions: the sense of having meaning and the sense of seeking meaning (Tang, 2008). It is found that the meaning in life may be an important factor in preventing suicidal ideation, and there is a significant negative correlation between the meaning in life and suicidal ideation in college students (Heisel and Flett, 2016; Zhang et al., 2022). The meaning in life can negatively predict suicidal ideation, and improving the meaning in life may help alleviate suicidal ideation (Jose and Angelina, 2019). According to the Stress-susceptibility Model, factors affecting suicidal ideation are mainly divided into protective factors and risk factors (Su et al., 2015). Protective factors such as meaning in life and positive coping style can reduce suicidal ideation (Chao et al., 2007). When people have a stronger meaning in life, they can experience more happiness and happiness, be more optimistic about the future, and have better psychological and social adjustment, which can effectively reduce the risk of suicidal ideation (Zhang and Li, 2018). According to the theory of meaning in lifey, self-awareness is an important cognitive basis for experiencing the meaning of life. When people understand themselves, the world and the relationship between themselves and the world, they can confirm the value of self-existence and thus experience the meaning in life. On the contrary, a sense of emptiness may arise, and even lead to suicidal ideation and behavior (Liu et al., 2013). Therefore, meaning in life may predict suicidal ideation in college students.

In addition, some studies have shown that college students' exercise adherence is significantly positively correlated with their meaning in life (Liu, 2012), and exercise adherence can positively predict their meaning in life (Yu, 2018). The higher the level of college students' exercise adherence, the higher the level of their meaning in life (Ding et al., 2016). The longitudinal research have shown that increasing exercise adherence improves adolescents' meaning in life (Wang et al., 2020). From the perspective of biological mechanism, maintaining physical exercise can affect cognitive aging by reshaping certain brain structures, promoting activation of brain regions related to cognitive function and the connection of functional networks, and can also affect brain function by improving the efficiency of neural processing, thus indirectly affecting psychological experience. Improve individual's understanding and grasp of life (Zhang and Gao, 2014). In addition, positive psychology believes that a better emotional state generated during physical exercise has an obvious effect on maintaining physical and mental health, and can stimulate and improve self-efficacy, which can affect the choice, duration, effort level and emotional state of an individual's behavior, to a certain extent, maintain the mood of an individual and stimulate students' positive and enterprising attitude. Finally, it can improve the sense of meaning of life (Zeng and Zhu, 2021). Therefore, we infer that exercise adherence may predict college students' meaning in life. To sum up, we propose the following hypothesis:

> *Hypothesis 2*: meaning in life plays an mediating role between exercise adherence and suicide ideation.

The mediating role of internet addiction

Internet addiction is a kind of pathological internet use behavior, which refers to a chronic state of addiction caused by repeated use of the internet, accompanied by increased tolerance and other psychological symptoms of addiction (Cao et al., 2022). Studies have shown that internet addicts have psychological disorders such as depression, loneliness and anxiety, and people with moderate depression are more likely to form internet addiction (Young, 2009). Research has confirmed that exercise adherence is an important factor in predicting college students' internet addiction, and improving college students' exercise adherence can effectively reduce internet addiction (Liu, 2018). The study found that most internet addicts lack physical exercise (Cheng, 2009). A meta-analysis shows that exercise adherence can play an intervention role in college students' internet addiction (Wu et al., 2018). An intervention experimental study showed that long-term physical exercise can significantly reduce the degree of college students' internet addiction (Zhang and Xu, 2022). From the perspective of biological mechanism, physical exercise can change the content of some neurotransmitters in the body, such as dopamine, 5-hydroxytryptamine and other monoamines as well as endorphins. At the same time, it can stimulate brain function at a wider level, so that individuals can better regulate negative emotions and generate positive emotions, improve loneliness, anxiety and other psychological conditions, promote mental health, and reduce internet addiction (Archer et al., 2015). Sports psychology shows that physical exercise has psychological benefits such as enhancing self-efficacy, reducing stress response and improving individual emotional state,

and these positive psychological benefits may have an inhibitory effect on suicidal ideation (Gao and Ren, 2019). Therefore, we infer that exercise adherence can negatively predict college students' internet addiction.

A large number of studies have proved that there is a certain correlation between internet addiction and suicidal ideation in college students (Wang and Meng, 2014), internet addiction and suicidal ideation in college students are significantly positively correlated (Wen et al., 2021), and internet addiction can positively predict suicidal ideation (Shi and Xie, 2019). The more serious the internet addiction is, the higher the suicidal ideation is, especially the female college students with internet addiction have a higher rate of suicidal ideation (Huang, 2018). An experimental study showed that college students with a high degree of internet addiction had a higher frequency of suicidal ideation than the control group (Fu et al., 2010). According to the Interpersonal Theory of Suicide proposed by Van et al. (2010), interpersonal psychology can predict and reveal suicidal behavior. But under the influence of internet addiction, college students will have bad social relations, mental health and other problems (Odacı and Çelik, 2013). According to the Stress-susceptibility Model of Suicide (Morgan, 2002), suicide is the result of the combination of individual diathesis and external stimuli. In the period of drastic changes in body and mind, college students with prominent rebellious psychology are prone to have impulsive thoughts including suicidal ideation under the stimulation of internet addiction. Therefore, we conclude that internet addiction can positively predict suicidal ideation. Finally, we propose the following hypothesis:

> *Hypothesis 3*: internet addiction plays an mediating role between exercise adherence and suicide ideation.

The chain mediating effect of meaning in life and internet addiction

Studies have found that meaning in life is closely related to internet addiction (Ge et al., 2018), meaning in life can negatively predict internet addiction in college students (Chen et al., 2019a; Cao et al., 2022), loss of meaning in life is an important cause of internet addiction in college students (Zhao et al., 2020). According to the Psychological Needs Theory of Internet Addiction, internet addiction is the result of individual psychological needs not being met in real life and seeking individual psychological needs through the internet (Liu et al., 2016). Individuals with long-term loss of meaning in life cannot meet their psychological needs in reality, and they are more likely to get "pathological compensation" through excessive use of the internet, which leads to internet addiction. At the same time, studies have found that individuals who use the internet excessively will also cause loss of meaning in life (Ge et al., 2018). There may be a two-way correlation between meaning in life and internet addiction. Once out of the internet world, it is easy to cause the loss of meaning in life, over and over again, the individual will aggravate the internet addiction, and then appear more serious psychological problems. Therefore, we propose the following hypothesis:

> *Hypothesis 4*: meaning in life and internet addiction play a chain mediating role between exercise adherence and suicidal ideation.

In summary, this study has four main purposes: (1) To test the negative predictive effect of exercise adherence on college students 'suicidal ideation; (2) To test the mediating role of meaning in life between exercise adherence and suicidal ideation; (3) To test the mediating effect of internet addiction between exercise adherence and suicidal ideation; (4) To test the chain mediating effect of meaning in life and internet addiction between exercise adherence and suicidal ideation (Figure 1).

Materials and methods

Procedure and participants

The stratified cluster sampling was used to select 2,102 undergraduate students from a university in Guangdong Province to complete the questionnaire survey. The invalid questionnaires with regular answers were deleted, and 1,925 valid questionnaires were obtained, with an effective recovery rate of 91.6%. The age range of the subjects was 18–21 years old, with an average age of 19.51 ± 2.393, including 890 boys (46.23%) and 1,035 girls (53.77%). There were 503 freshmen, 406 sophomores, 512 juniors and 504 seniors.

This study was approved by the Research Ethics Committee of Zhaoqing University (No. 2022-1207-01). The collective test was adopted. Before the survey, the students were explained that the questionnaire was anonymously answered, emphasizing voluntary filling. The content is strictly confidential, and the results are only for scientific research. All questionnaires were collected on the spot. All subjects were informed of the purpose and characteristics of the study and signed informed consent. The experimenters were professionally trained college students.

Measures and instruments

Exercise adherence

The Exercise Adherence Scale revised by Liu et al. (2011) was used to evaluate exercise adherence. The scale is based on the theory of sports commitment, a total of 6 items (e.g., participating in physical exercise has become a habit for me), using Likert 5-point evaluation, 1 represents completely disagree, 5 represents completely agree. The total score represents the level of exercise adherence. The higher the score, the higher the level of sports adherence. The research proves that the questionnaire has good applicability in college students (Dong and Mao, 2018). In this study, the Cronbach's α coefficient of the scale was 0.942.

Meaning in life

In this study, the Chinese version of the meaning in life scale compiled by Steger et al. (2006) and revised by Wang and Dai (2008) was used to test the subjects. A total of 10 topics, including a sense of meaning and seek a sense of meaning 2 dimensions, such as "I am looking for my life goal or mission," "my life has no clear purpose" and so on. The scale uses Likert 7 points to score, from "completely inconsistent" to "completely consistent," 1–7 points, respectively. The higher the score, the higher the meaning of life of the subjects. Studies have shown that the scale has good reliability and validity among Chinese college students (Zhu et al., 2022). In this study, the Cronbach α coefficient of the scale was 0.945.

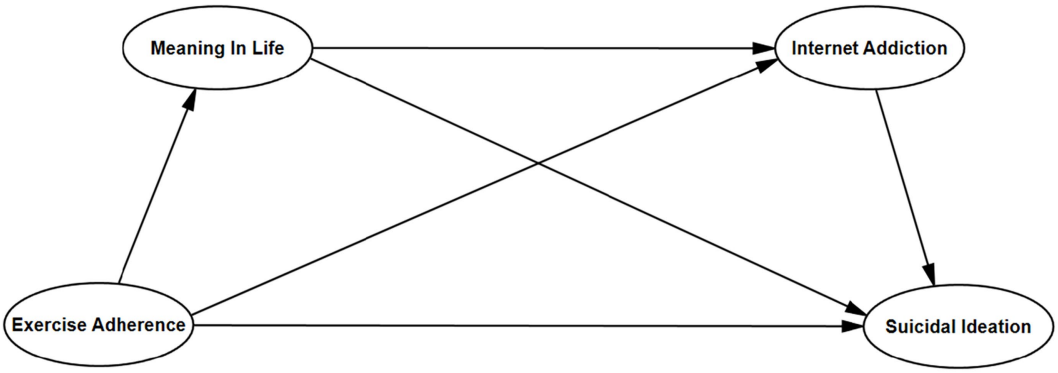

FIGURE 1
Concept framework.

Internet addiction

The Chinese version of Internet Addiction Scale revised by Young (2009) was adopted, there are 8 items in the scale, each item is answered with "yes" or "no." The answer "no" is 1 point, and the answer "yes" is 2 points. The average score of the 8 items is calculated. The higher the score, the higher the tendency of internet addiction. The research has proved that the scale has good reliability and validity among Chinese college students (Cao et al., 2022). In this study, the Cronbach α coefficient of the scale was 0.907.

Suicidal ideation

The suicidal ideation scale was developed by You et al. (2014) was used to evaluate suicidal ideation. The scale consisted of two items ("Have you seriously considered ending your life before" and "Have you seriously considered ending your life in the past year"). Both items were scored by 3 points, 1 representing "never," 2 representing "occasionally," and 3 representing "often." If and only if the subjects 'scores on both items are 1, that is, the total score is 2, it means that they have no suicidal ideation, and the higher the score, the more serious the suicidal ideation. The scale showed high reliability and validity on Chinese college students (Wu et al., 2022). In this study, the Cronbach α coefficient of the scale was 0.874.

Design and statistical analysis

Amos 26.0, SPSS26.0 and SPSS PROCESS plug-ins (Hayes, 2018) were used for data statistics and analysis. Firstly, Harman single factor test was used to test the common method deviation. Secondly, mean and standard deviation were used for descriptive statistics, and Pearson Correlation Coefficient was used to test the correlation between variables. Thirdly, We use Amos 26.0 to calculate fit indicators. Finally, taking exercise adherence as the independent variable, gender and grade as the control variable, suicide ideation as the dependent variable, meaning in life and internet addiction as the intermediary variable, the independent intermediary effect test was conducted using the Non-parametric Percentile Bootstrap Method (sample size 5,000, 95% confidence interval) and Model 4 in process, and the chain intermediary effect test was conducted with Model 6.

Results

Common method bias test

Harman single factor test was used to test the common method deviation. The results showed that there were 6 factors with characteristic roots greater than 1, and the cumulative variation of the first common factor explanation was 38.35%, which was less than the standard critical value of 40%, indicating that there was no serious common method bias in this study.

Descriptive statistics and correlation analysis

As shown in Table 1, the correlation coefficients of exercise adherence, suicidal ideation, meaning in life and internet addiction were statistically significant. Correlation analysis showed that exercise adherence was negatively correlated with suicidal ideation and internet addiction, and positively correlated with meaning in life. Suicidal ideation was positively correlated with internet addiction and negatively correlated with meaning in life. Meaning in life was significantly negatively correlated with internet addiction. The relationship between variables supports the test of subsequent hypotheses.

Mediating effect test of meaning in life and internet addiction

SPSS Process model 6 combined with Bootstrap method was used to test the mediating effect of meaning in life and internet addiction between exercise adherence and suicidal ideation after 5,000 sampling and controlling for gender and age. The results of regression analysis showed (Table 2) that exercise adherence can significantly and positively predict suicide ideation ($\beta = -0.467$, $t = -23.178$, $p < 0.01$), and hypothesis 1 of this study was verified. Exercise adherence can significantly and positively predict the meaning in life ($\beta = 0.355$, $t = 16.767$, $p < 0.01$), meaning in life can significantly predict suicide ideation negatively ($\beta = -0.182$, $t = -10.198$, $p < 0.01$), exercise adherence can significantly negatively predict internet addiction

TABLE 1 Means, standard deviations, and correlations among variables.

Variable	*M*	SD	Gender	1	2	3	4
Gender			1				
1. EA	21.71	5.664	0.008	1			
2. SI	2.37	0.952	0.041	−0.467**	1		
3. MIL	52.36	11.532	−0.101**	0.355**	−0.602**	1	
4. IA	1.094	0.223	0.02	−0.454**	0.772**	−0.622**	1

$N = 1925$. EA = exercise adherence, SI = suicidal ideation, MIL = meaning in life, IA = internet addiction. **$p < 0.01$.

TABLE 2 Analysis of regression relationship among variables.

Effect	Item	Effect	SE	*t*	*p*	LLCI	ULCI
Direct effect	EA ⇒ SI	−0.131	0.016	−8.361	< 0.01	−0.161	−0.100
Indirect Effect Process	EA ⇒ MLI	0.355	0.021	16.767	< 0.01	0.314	0.397
	EA ⇒ IA	−0.265	0.018	−14.634	< 0.01	−0.301	−0.230
	MIL⇒IA	−0.531	0.018	−29.181	< 0.01	−0.567	−0.496
	MIL⇒SI	−0.182	0.018	−10.198	< 0.01	−0.217	−0.147
	IA ⇒ SI	0.599	0.019	32.112	< 0.01	0.562	0.635
Total effect	EA ⇒ SI	−0.467	0.020	−23.178	< 0.01	−0.507	−0.428

EA = exercise adherence, SI = suicidal ideation, MIL = meaning in life, IA = internet addiction.
LLCI is the lower 95% limit for Bootstrap sampling and ULCI is the upper 95% limit for Bootstrap sampling.

($\beta = -0.265$, $t = -14.634$, $p < 0.01$), internet addiction can significantly predict suicide ideation ($\beta = 0.599$, $t = 32.112$, $p < 0.01$), the meaning in life can significantly negatively predict internet addiction ($\beta = -0.531$, $t = -29.181$, $p < 0.01$).

It can be seen from the further Bootstrap test results (Table 3) that the total indirect effect value is −0.336, accounting for 50.15% of the total effect value, and the confidence interval does not include 0, which indicates that the mediation effect between the meaning in life and internet addiction is significant between exercise adherence and suicide ideation. It consists of the following three paths:

Indirect effect 1, exercise adherence → meaning in life → suicide ideation, the effect value is −0.065, accounting for 19.35% of the total effect value, the confidence interval does not include 0, and the indirect effect is significant. Hypothesis 2 is supported.

Indirect effect 2, exercise adherence → internet addiction → suicide ideation, the effect value is −0.159, accounting for 47.32% of the total effect value, the confidence interval does not include 0, and the indirect effect is significant. Hypothesis 3 is verified.

Indirect effect 3, exercise adherence → meaning in life → internet addiction → suicide ideation, the effect value is −0.112, accounting for 33.33% of the total effect value, and the confidence interval does not include 0. The indirect effect of this path is significant. Hypothesis 4 of this study has also been verified. The mediating effect of meaning in life and internet addiction between exercise adherence and suicidal ideation is shown in Figure 2.

Discussion

This study explored the relationship between exercise adherence and suicidal ideation of college students, as well as the mediating role of meaning in life and internet addiction. The results showed that exercise adherence could not only directly and negatively predict suicidal ideation, but also indirectly predict suicidal ideation through the separate mediating role of meaning in life and internet addiction, as well as the chain mediating role of the two. It further explains the reasons for the effect of exercise adherence on college students 'suicidal ideation, which has certain enlightenment significance for inhibiting and preventing college students 'suicidal ideation.

Exercise adherence and suicidal ideation

This study confirmed that exercise adherence can significantly negatively predict suicidal ideation in college students. Hypothesis 1 is tested. The monoamine hypothesis holds that long-term physical exercise can not only promote brain microcirculation and improve the level of monoamine neurotransmitters in the brain, but also accelerate blood circulation and improve human metabolism, thus achieving the purpose of controlling individual adverse emotions (Wei and Yang, 2020). An important motivation for individuals to persist in physical exercise is to increase social opportunities, which can increase group identity and social reinforcement, and easily form social support networks with others, thus reducing the incidence of suicidal ideation. According to the Torsion Theory, psychological torsion does not necessarily lead to college students' suicidal behavior, but the relationship between torsion and suicidal behavior may be regulated by social integration, social adjustment and psychological factors such as personality (Zhang et al., 2011). As an external protective factor, physical exercise can reduce the psychological torque of college students by playing the role of social integration or social regulation, thus affecting the generation of their suicidal ideation. According to the theory of sports psychology, physical exercise is conducive to generating positive emotions and alleviating negative emotions, which can promote the improvement of individual emotional regulation ability. Meanwhile, positive emotion management strategies help reduce the level of suicidal ideation of individuals (Lei et al., 2021). This suggests that, in the prevention and intervention of suicidal

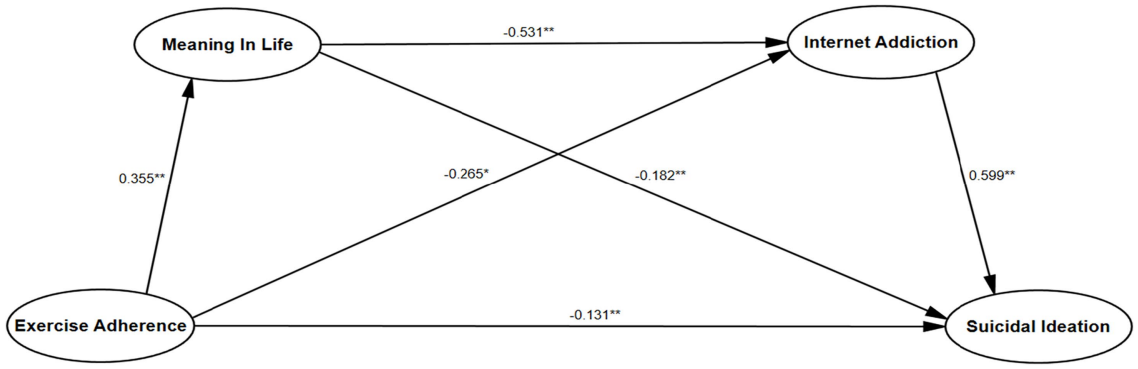

FIGURE 2
Chain mediating model of meaning in life and internet addiction between exercise adherence and suicidal ideation.

TABLE 3 Mediation effect and effect size.

Path	Effect	Proportion of total (%)	95% confidence interval	
			Boot LLCI	Boot ULCI
EA → MIL→SI	−0.065	19.35	−0.086	−0.047
EA → IA → SI	−0.159	47.32	−0.190	−0.129
EA → MIL→IA → SI	−0.112	33.33	−0.141	−0.088
Total effect	−0.336		−0.393	−0.283

EA = exercise adherence, SI = suicidal ideation, MIL = meaning in life, IA = internet addiction.

ideation in college students, exercise adherence can be regarded as a dominant external effective intervention factor into primary prevention measures, or it can be regarded as a relatively safe external protective factor to promote and pay attention to, so as to prevent the generation of suicidal ideation.

Independent mediating effect of meaning in life

This study found that the meaning in life played a mediating role between exercise adherence and suicide ideation, which verified hypothesis 2. This is consistent with previous relevant research evidence, that is, exercise adherence significantly positively predicted meaning in life (Yu, 2018), and meaning in life negatively predicted suicide ideation (Zhang et al., 2022). This study takes three variables into consideration at the same time, revealing that exercise adherence is an important factor to promote the meaning in life, and also an important factor to prevent suicide ideation.

On the one hand, exercise adherence has a positive predictive effect on the meaning in life. The possible reasons are as follows: First, exercise adherence can not only improve the learning efficiency, social support and physical health of teenagers, but also affect the brain function through the brain nervous system, change depression, and effectively improve the meaning in life of individual life (Jiang et al., 2018). Second, physical exercise can promote the secretion of endorphins, make people feel happy and refreshed, and make individuals feel energetic, excited and full, so as to improve the meaning in life (Ding and Fan, 2002). Third, individuals with high exercise adherence can often achieve the established exercise goals, which is extremely beneficial to promote the individual's sense of goal. In addition, good performance in competitive and cooperative exercise can also make individuals feel a sense of achievement and autonomy, which is conducive to improving the meaning in life.

On the other hand, meaning in life can negatively predicted suicidal ideation. Studies have shown that people with a high meaning in life have more expectations for life, and even when they encounter setbacks, they can also show strong psychological resilience in difficulties. They will not waver in their search for meaning of life due to the influence of external factors, and they will turn adversity, failure and temporary setbacks into action. This also indicates that the meaning in life has a positive effect on the prevention of suicidal ideation (Zhang et al., 2021). However, people with no meaning in life in their lives tend to suffer more psychological pain (Schulenberg, 2004). This may be because hope is an integral part of the meaning in life (Feldman and Snyder, 2005). When individuals lose their meaning in life, their goal-orientation will weaken and they will gradually lose hope for the future, low hope is associated with suicidal ideation to some extent (Snyder et al., 1991). Therefore, enhancing the meaning in life can reduce the suicidal ideation of college students.

Independent mediating effect of internet addiction

This study also found that internet addiction plays a mediating role between exercise adherence and suicidal ideation, which verified hypothesis 3. This is consistent with previous relevant research evidence, that is, exercise adherence significantly negatively predicted internet addiction (Liu, 2018), and internet addiction significantly positively predicted suicide ideation (Wen et al., 2021).

This study confirmed that exercise adherence significantly negatively predicted internet addiction. The possible reasons are as follows: First of all, according to psychological theory, most college students with internet addiction have a certain degree of mental health disorders and cognitive disorders, and exercise adherence can improve individual psychological satisfaction (Teng, 2007), and promote the development of their socialization and cognitive ability (Yang and Xu,

2016), which is conducive to reducing internet addiction. Studies have shown that adolescent internet addiction is related to long-term depression, irritability, depression and other factors. Physical exercise can alleviate the confusion, anxiety, depression and other unhealthy mental states of internet addiction patients, so as to alleviate or even eliminate internet addiction (Liu, 2018). Secondly, according to the physiological theory, long-term physical exercise can make the exerciter's pituitary gland secrete endorphins, which compete with addictive substances in the central nervous system for receptors, so that the individual produces a sense of happiness, and thus inhibits the attack of internet addiction (Jelena and Natasa, 2011).

In addition, this study found that internet addiction can predict suicidal ideation. The reasons are as follows: First, college students addicted to the internet are more likely to obtain information about suicide through relevant websites and forums. Secondly, according to the interpersonal theory of suicide, interpersonal psychology can predict and reveal suicidal ideation. Individuals with internet addiction spend too much time on the internet, take the network world as the real world, and are divorced from the times, have no common language with other people, and seriously lack social communication and interpersonal communication, resulting in loneliness and anxiety, depression, irritability and impulse and other adverse symptoms. Internet addicts not only damage their academic performance and interpersonal relationships, but also become restless when faced with more stressful life events, eventually leading to suicidal ideation and behavior (Pan et al., 2018).

Chain mediating effect of meaning in life and internet addiction

This study confirmed the chain mediating effect of meaning in life and internet addiction, which is consistent with previous studies (Cao et al., 2022). Hypothesis 4 is verified. This study found that meaning in life can negatively predict internet addiction. The meaning in life is the perception of self-worth, individuals with low meaning in life are difficult to feel the value and meaning of their own existence in real life, and are prone to have a sense of boredom and confusion in life, as well as a great pressure and a psychology of escaping from reality. Online games and online social networking are the common ways for college students to reduce boredom and escape pressure today (Chen et al., 2019b). Therefore, college students with low meaning in life are more prone to internet addiction. Individuals with a high meaning in life are easy to find the meaning and goal of life, obtain the joy and spiritual enrichment of life, and experience positive emotions (Nie and Gan, 2017). Therefore, individuals with high meaning in life are not easy to cause internet addiction. In conclusion, the higher the exercise adherence of college students, the higher the meaning in life, the lower the internet addiction, and ultimately the lower the generation and development of suicidal ideation.

Practical significance

This study examined the effect of exercise adherence on suicidal ideation, enriched the field of exercise adherence and suicidal ideation related research, to reduce college students suicidal ideation has a certain practical significance. First, exercise adherence is an important predictor of suicidal ideation. College students currently have a high suicide rate and should be given full attention. Suicide ideation is negatively correlated with individual sense of life meaning and positively correlated with internet addiction. Exercise adherence can not only positively predict sense of life meaning and negatively predict internet addiction, but also play an important role in predicting college students 'suicidal ideation. Therefore, ensuring the adherence of college students 'physical exercise should be an important part of college education. In improving the adherence of physical exercise, we should not only pay attention to the external environment factors, such as family sports environment, community sports environment and school sports environment, but also pay attention to the development of personality psychological characteristics, such as self-management, goal setting, self-monitoring. Teachers, especially physical education teachers, should create conditions for students to have good physical education and extracurricular physical exercise according to the characteristics of students' physical and mental development, which can provide direct help for stimulating college students to adhere to physical exercise. Secondly, the sense of life meaning and internet addiction are important factors affecting college students 'suicidal ideation. The mediating role of the sense of life meaning and internet addiction suggests that educators should pay attention to the influence of the sense of life meaning and internet addiction on college students 'suicidal ideation. They should pay attention to improve the level of college students' sense of life meaning and reduce internet addiction, improve the ability to deal with stressful events, treat problems with an objective and rational attitude, and actively respond to the pressure of life, study and work, so as to enhance the effect of exercise adherence on college students 'mental health and reduce their suicidal ideation.

Limitations and prospectives

Firstly, the conclusion of this study is based on the analysis of data. The collection of data comes from self-report. In the future, we can integrate various data collection methods to explore the impact of exercise adherence on suicidal ideation. Secondly, this study adopts a cross-sectional study design. In the future, the method of tracking research can be applied to deeply reveal the relationship between variables. Thirdly, this study found that meaning in life and internet addiction play a partial mediating role between exercise adherence and suicidal ideation. There may be other mediating variables in the relationship between the two. In the future, the comprehensive influence of multiple mediating variables can be considered. Fourthly, a consequence of the cross-sectional study design is the impossibility of determining the direction of effects between variables and confirming the presented conceptual model. Finally, according to the theory of meaning in life, the conceptual model can be: meaning in life → suicidal ideation. In this model, it may be meaningful to use exercise adherence and internet addiction as regulatory factors, as both factors are under the control of young people.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding authors.

Ethics statement

This study was approved by the Research Ethics Committee of Zhaoqing University (No. 2022-1207-01). The collective test was adopted. Before the survey, it was explained to the students that the questionnaire was anonymously answered, emphasizing voluntary filling, and that the content is strictly confidential, and the results are only for scientific research. All questionnaires were collected on the spot. All subjects were informed of the purpose and characteristics of the study and signed informed consent.

Author contributions

KG designed the study. ZX collected and analyzed the data, and wrote the manuscript. ZH and QM revised the manuscript. All authors contributed to the article and approved the submitted version.

Funding

This research was funded by (1) 2022 Education Science Planning Project (Higher Education Special; grant number: 2022GXJK356); (2) 2021 Guangdong Undergraduate Teaching Quality and Teaching Reform Project—Teaching and Research Office of School Physical Education Curriculum Group, Serial number 96; (3) 2021 Zhaoqing University Quality Engineering and Teaching Reform project, grant number zlgc202111; and (4) Major Topics of Higher Education Scientific Research Plan in 2022, grant number 22JS0102.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Archer, T., Torbjorn, J., and Magnus, L. (2015). Effects of physical exercise on depressive symptoms and biomarkers in depression. *CNS Neurol. Disord. Drug Targets* 13, 1640–1653. doi: 10.2174/1871527313666141130203245

Brown, D. R. (2005). Physical activity, sports participation, and suicidal behaviors: a literature review. *Int. J. Sport Exerc. Psychol.* 3, 484–500. doi: 10.1080/1612197X.2005.10807320

Cao, R. L., Mei, S. L., Liang, L. L., Li, C. E., and Zhang, Y. (2022). The relationship between gratitude and internet addiction in college students: the mediating role of core self-evaluation and sense of meaning in life. *Psychol. Dev. Educ.* 38, 286–294. doi: 10.16187/j.cnki.issn1001-4918.2023.02.15

Chao, C. X. (2018). Influencing factors of suicide ideation in Chinese college students. *Health Med. Res. Pract.* 15, 81–85+90. doi: 10.11986/j.issn.1673-873X.2018.06.023

Chao, C. X., Liu, J. P., Zeng, X. Q., Mao, J. L., and Zhou, M. (2007). Comparison of coping styles among college students with or without suicidal ideation. *Chin. J. Mental Health* 36:102. doi: 10.3321/j.issn:1000-6729.2007.02.011

Chen, L. S., Bao, J. W., and Huang, R. (2019a). The relationship between life meaning, pathological internet use and time Management of College students. *Chin. J. Health Psychol.* 27, 919–923. doi: 10.13342/j.cnki.cjhp.2019.06.012

Chen, Y. X., Lou, J., Zhang, P., and Liu, X. P. (2019b). Qualitative research on problematic social networks usage in college students. *Chin. J. Mental Health* 33, 143–148. doi: 10.3969/j.issn.1000-6729.2019.02.013

Cheng, F. (2009). On the lack of sports among the teenagers with internet addiction. Ph.D. thesis. Wuhan Institute of Physical Education.

Ding, Q. J., and Fan, F. (2002). Study on the effect of exercise prescription on the correction of psychological disorder in college students. *J. Beijing Sport Univ.* 25, 468–470. doi: 10.19582/j.cnki.11-3785/g8.2002.04.013

Ding, S. Y., Xiao, R., and Zhang, Z. (2016). The relationship between college students' physical exercise and life meaning. *Chin. School Health* 37, 445–448. doi: 10.16835/j.cnki.1000-9817.2016.03.037

Dong, B. L., and Mao, L. J. (2018). Core belief, active rumination and exercise persistence of college students: the mediating effect of exercise atmosphere. *J. Tianjin Institute Phys. Educ.* 33, 441–447. doi: 10.13297/j.cnki.issn1005-0000.2018.05.011

Feldman, D. B., and Snyder, C. R. (2005). Hope and the meaningful life: theoretical and empirical associations between goal–directed thinking and life meaning. *J. Soc. Clin. Psychol.* 24, 401–421. doi: 10.1521/jscp.24.3.401.65616

Fu, K. W., Chan, W., Wong, P., and Yip, P. (2010). Internet addiction: prevalence, discriminant validity and correlates among adolescents in Hong Kong. *Br. J. Psychiatry* 196, 486–492. doi: 10.1192/bjp.bp.109.075002

Gao, Y. Y., and Ren, S. Y. (2019). The effect of physical activity on suicidal ideation in high school students: the mediating role of mental health. *Hubei Sports Sci. Technol.* 38, 992–995+1001. doi: 10.3969/j.issn.1003-983X.2019.11.012

Ge, Y., Deng, L. Y., and Ji, L. C. (2018). Relationship between personality traits, internet efficacy and life meaning of left-behind children in cities with internet addiction. *Special Educ. China* 212, 89–96. doi: 10.3969/j.issn.1007-3728.2018.02.016

Hayes, A. F. (2018). *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-based Approach. 2nd* Edn New York: Guilford Press.

Heisel, M. J., and Flett, G. L. (2016). Does recognition of meaning in life confer resiliency to suicide ideation among community-residing older adults? A longitudinal investigation. *Am. J. Geriatr. Psychiatry* 24, 455–466. doi: 10.1016/j.jagp.2015.08.007

Huang, Y. (2018). Suicidal behavior characteristics and suicide risk assessment of adolescent internet addicts. Ph.D. thesis. Chongqing Medical University.

Jelena, J., and Natasa, D. (2011). Influence of dopaminergic system on internet addiction. *Acta Medica Medianae.* 50, 60–66. doi: 10.5633/amm.2011.0112

Jiang, Y., Zhang, L. W., and Mao, Z. X. (2018). Physical exercise and mental health: the role of emotion regulation self-efficacy and emotion regulation strategies. *Psychol. Behav. Res.* 16, 570–576. doi: 10.3969/j.issn.1672-0628.2018.04.020

Jose, S., and Angelina, J. (2019). Development of psycho-spiritual meaning intervention on depression and suicide ideation among young adults: a pilot study. *Indian J. Posit. Psychol.* 10, 249–252.

Lei, Q. L., Liao, M. L., Jia, J., Wang, L. L., and Jiang, Q. (2021). Study on the relationship between physical exercise, emotional regulation and suicidal ideation of medical students. *Fujian Sports Sci. Technol.* 40, 14–19. doi: 10.3969/j.issn.1004-8790.2021.05.004

Liu, L. (2012). Study on the relationship between physical exercise and life satisfaction and life meaning of college students. Ph.D. thesis. Zhengzhou University.

Liu, F. M. (2018). Study on the correlation between physical exercise and internet addiction of middle school students in Guangdong Province. *Sports Sci. Technol. Lit. Bull.* 26, 14–17. doi: 10.19379/j.cnki.issn.1005-0256.2018.02.006

Liu, Q. X., Fang, X. Y., Wan, J. J., and Zhou, Z. K. (2016). Need satisfaction and adolescent pathological internet use. *Comput. Hum. Behav.* 55, 695–700. doi: 10.1016/j.chb.2015.09.048

Liu, H. Y., and Wang, W. (2019). The relationship between autistic traits and suicidal ideation: the mediating role of alexithymia and depression. *Chin. J. Clin. Psych.* 27, 889–893. doi: 10.16128/j.cnki.1005-3611.2019.05.007

Liu, Y., Zhang, Y., Shi, X. Z., and Liang, D. W. (2014). Influence of psychosocial factors on suicidal ideation of medical students. *Chin. Public Health* 30, 269–272. doi: 10.11847/zgggws2014-30-03-05

Liu, Y. X., Zhang, J. W., Zhang, X. C., Wang, C. Q., and Zhang, J. (2013). The mechanism of new generation employees' suicide ideation. *Adv. Psychol. Sci.* 21, 1150–1161. doi: 10.3724/SP.J.1042.2013.01150

Liu, W. N., Zhou, C. L., and Sun, J. (2011). The influence of outdoor exercise motivation on exercise persistence of adolescents: the mediating role of exercise atmosphere. *Sports Sci.* 31, 41–47. doi: 10.16469/j.css.2011.10.006

Mirim, M., Oivind, E., Per, V., and Reidar, T. (2008). Mental health treatment needs for medical students: a national longitudinal study. *Eur. Psychiatry* 23, 505–511. doi: 10.1016/j.eurpsy.2008.04.006

Morgan, G. (2002). Understanding suicidal behaviour: the suicidal process approach to research, treatment and prevention. *Br. J. Psychiatry* 180:190. doi: 10.1192/bjp.180.2.190

Nie, H. Y., and Gan, Y. Q. (2017). The relationship between self-concept clarity, life meaning and subjective well-being. *Chin. J. Clin. Psych.* 25, 923–927. doi: 10.16128/j.cnki.1005-3611.2017.05.029

Odacı, H., and Çelik, Ç. B. (2013). Who are problematic internet users? An investigation of the correlations between problematic internet use and shyness, loneliness, narcissism, aggression and self-perception. *Comput. Hum. Behav.* 29, 2382–2387. doi: 10.1016/j.chb.2013.05.026

Pan, S. Y., Li, W. Q., Li, M., Guo, L., Deng, X. Q., and Lu, C. Y. (2018). The relationship between internet addiction and suicide-related behaviors among middle school students in Guangzhou. *Chin. School Health* 39, 229–231. doi: 10.16835/j.cnki.1000-9817.2018.02.021

Schulenberg, S. E. (2004). A psychometric investigation of logotherapy measures and the outcome questionnaire (oq-45.2). *N. Am. J. Psychol.* 6, 477–492.

Shang, Y. X., Dong, G. Q., and Liu, T. (2008). Analysis of influencing factors of suicidal ideation and depression among college students in Yinchuan City. *Chin. Public Health* 24, 934–936.

Shi, Z. F., and Xie, Y. T. (2019). The effect of problematic internet use on suicidal ideation in junior middle school students: a moderated mediation model. *Psychol. Dev. Educ.* 35, 581–588. doi: 10.16187/j.cnki.issn1001-4918.2019.05.09

Snyder, C. R., Harris, C., Anderson, J. R., Holleran, S. A., Irving, L. M., Sigmon, S. T., et al. (1991). The will and the ways: development and validation of an individual-differences measure of hope. *J. Pers. Soc. Psychol.* 60, 570–585. doi: 10.1037/0022-3514.60.4.570

Steger, M. F., Frazier, P., Oishi, S., and Kaler, M. (2006). The meaning in life questionnaire: assessing the presence of and search for meaning in life. *J. Couns. Psychol.* 53, 80–93. doi: 10.1037/0022-0167.53.1.80

Su, B. Y., Zhang, W., Zhou, M. P., Lin, M., and Meng, C. (2015). Identification and warning of potential suicide risk in college students: based on stress-susceptibility model. *J. South China Normal Univ. (Soc. Sci. Edn.)* 215, 78–84.

Tang, X. M. (2008). The education of caring the sense of life meaning. *Educ. Res. Exp.* 26, 43–46.

Teng, H. Y. (2007). On physical exercise and network mental health of college students. *J. Beijing Sport Univ.* 49, 772–773+780. doi: 10.19582/j.cnki.11-3785/g8.2007.06.017

Van, O., Kimberly, A., Witte, T. K., Cukrowicz, K. C., Braithwaite, S., Selby, E. A., et al. (2010). The interpersonal theory of suicide. *Psychol. Rev.* 117, 575–600. doi: 10.1037/a0018697

Wang, M. C., and Dai, X. Y. (2008). Chinese meaning in life questionnaire revised in college students and its reliability and validity test. *Chin. J. Clin. Psych.* 16, 459–461. doi: 10.16128/j.cnki.1005-3611.2008.05.020

Wang, C. T., Han, T. T., and Zhang, J. (2022). Analysis of external protective factors of suicidal ideation in college students. *Chin. J. Mental Health.* 36, 243–247. doi: 10.3969/j.issn.1000-6729.2022.03.010

Wang, M., Kou, C., Bai, W., Song, Y., Liu, X., Yu, W., et al. (2019). Prevalence and correlates of suicidal ideation among college students: a mental health survey in Jilin Province, China. *J. Affect. Disord.* 246, 166–173. doi: 10.1016/j.jad.2018.12.055

Wang, X., and Meng, X. H. (2014). The correlation between internet addiction and suicidal behavior in a vocational college students. *Chin. School Health* 35, 1020–1021+1024. doi: 10.16835/j.cnki.1000-9817.2014.07.023

Wang, S., Wang, H. Y., Liang, J. H., and Li, S. (2020). Research on the relationship between physical exercise and wisdom, social support and life meaning of adolescents. *Sichuan Sports Sci.* 39, 61–66. doi: 10.13932/j.cnki.sctykx.2020.03.15

Wang, S., Zhang, J. M., and Liu, Y. P. (2018). Research on the effective factors of sports APP in promoting public exercise persistence. *J. Fujian Normal Univ. (Phil. Soc. Sci. Edn.)* 63, 88–99–170–171. doi: 10.12046/j.issn.1000-5285.2018.06.012

Wei, C. (2018). The enlightenment of low suicidal ideation of physical education students to mental health education in colleges. Ph.D. thesis. Wuhan University of Technology.

Wei, T. P., and Yang, Y. Q. (2020). Research progress of physical exercise in the treatment of depression. *Sports Sci. Technol. Lit. Bull.* 28, 67–69. doi: 10.19379/j.cnki.issn.1005-0256.2020.10.027

Wen, L. F., Gong, J. H., Maidina, A., Ma, Y. N., Lv, J., Huang, X. M., et al. (2021). Study on the status quo and influencing factors of adolescent negative sexual events in Luohu District of Shenzhen city. *Pract. Prevent. Med.* 28, 1479–1483. doi: 10.3969/j.issn.1006-3110.2021.12.017

Wu, C. Z., Huang, T. T., Wang, T., Yu, L. X., and Sun, Q. W. (2022). The effect of basic psychological needs satisfaction on suicidal ideation of college students: the mediating role of life responsibility and the moderating role of self-differentiation. *Chin. J. Clin. Psych.* 30, 949–953. doi: 10.16128/j.cnki.1005-3611.2022.04.038

Wu, J., Zhan, H., Du, Z. Z., and Wu, F. J. (2018). Meta-analysis of the effect of exercise prescription on adolescent internet addiction. *Sports Sci.* 39, 46–54. doi: 10.13598/j.issn1004-4590.2018.03.008

Yang, J. P., and Xu, J. (2016). The Influence of Physical Exercise attitude on the aerobic fitness of adolescents: the mediating role of physical exercise behavior. *J. Phys. Educ. Sport* 36, 91–96. doi: 10.3969/j.issn.1007-323X.2016.01.023

You, Z., Song, J., Wu, C., Qin, P., and Zhou, Z. (2014). Effects of life satisfaction and psychache on risk for suicidal behaviour: a cross-sectional study based on data from Chinese undergraduates. *BMJ Open* 4, –e004096. doi: 10.1136/bmjopen-2013-004096

Young, K. S. (2009). Internet addiction: the emergence of a new clinical disorder. *CyberPsychol. Behav.* 1, 237–244. doi: 10.1089/cpb.1998.1.237

Yu, Y. F. (2018). A study on the relationship between physical exercise and life meaning of students majoring in physical education in Tonghua Normal university. *Manag. Rural Health Services China* 38, 1044–1047. doi: 10.3969/j.issn.1005-5916.2018.08.024

Zeng, J. X., and Zhu, H. X. (2021). Research on the influence of physical exercise on sense of life significance of college students in Shenzhen *Bulletin of Sport Science and Technology*. 29, 131–134+167. doi: 10.19379/j.cnki.issn.1005-0256.2021.11.045

Zhang, L. C., and Gao, S. Q. (2014). Delay effect of physical exercise on cognitive aging: evidence from brain science. *J. TUS.* 29, 309–312+318. doi: 10.13297/j.cnki.issn1005-0000.2014.04.007

Zhang, J., Jing, J., Wu, X. Y., Sun, W. W., and Wang, C. T. (2011). Sociological analysis of the downward trend of suicide rate in China. China. *Soc. Sci.* 191, 97–113+221.

Zhang, R. W., and Li, D. (2018). How to live a meaningful life?–integration of theoretical models based on the meaning of life. *Adv. Psychol. Sci.* 26, 744–760. doi: 10.3724/SP.J.1042.2018.00744

Zhang, P., Wang, P., Zhang, D., and Zhang, L. G. (2022). The effect of self-concept clarity and sense of life meaning on suicidal ideation of college freshmen. *Chin. J. Mental Health* 36, 975–980. doi: 10.3969/j.issn.1000-6729.2022.11.012

Zhang, W., and Xu, R. (2022). Effect of exercise intervention on internet addiction and autonomic nervous function in college students. *Bio. Med. Res. Int.* 2022, 1–7. doi: 10.1155/2022/5935353

Zhang, Y., Yuan, B., Wang, K., and Shen, T. (2021). The influence of impulsivity on suicidal ideation in high school students: the role of campus exclusion and sense of meaning in life. *Psychol. Behav. Res.* 19, 89–95. doi: 10.3969/j.issn.1672-0628.2021.01.013

Zhao, H. Y., Li, X. F., Zhou, J. X., Nie, Q. Q., and Zhou, J. H. (2020). The relationship between bullying victimization and online game addiction among Chinese early adolescents: the potential role of meaning in life and gender differences. *Child Youth Serv. Rev.* 116:105261. doi: 10.1016/j.Childyouth.2020.105261

Zhu, L. J., Yang, Q., Ye, B. J., Chen, Z. N., and Zhang, L. (2022). The effect of natural connection on depression in college students: a moderated mediation model. *Psychol. Dev. Educ.* 38, 886–893. doi: 10.16187/j.cnki.issn1001-4918.2022.06.15

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 07 June 2023
DOI 10.3389/fpsyg.2023.1118741

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RECEIVED 07 December 2022
ACCEPTED 02 May 2023
PUBLISHED 07 June 2023

CITATION
Parti K (2023) What is a capable guardian to older fraud victims? Comparison of younger and older victims' characteristics of online fraud utilizing routine activity theory. *Front. Psychol.* 14:1118741. doi: 10.3389/fpsyg.2023.1118741

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What is a capable guardian to older fraud victims? Comparison of younger and older victims' characteristics of online fraud utilizing routine activity theory

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Objective: The paper compares victim group characteristics: we test routine activities theory to compare the differences in online fraud vulnerabilities of victims aged 18–54 and victims of 55 and above.

Methods/sample: A representative sample of US citizens 18 and above was collected in October 2020. Victims under 55 encompassed 35.3% (n=915), victims 55 and above 12.9% (n=334) of the total sample (n=2,589). We utilized non-parametric statistical methods for testing whether older and younger victims' characteristics can be derived from the same independent variables.

Results: Computer time, computer familiarity, and technical guardians determine online victimization in older individuals, similarly to younger age groups. However, older victims differ in characteristics from younger victims. Seniors were less likely to apply technical guardians such as camera cover, identity theft monitoring, and credit card freeze, even after experiencing online scams. Being a single parent was a protective factor for older individuals, but having a full-time job made older individuals more prone to experience online fraud victimization compared to being retired. In addition, older victims were less likely to report scams than younger ones.

Conclusion/implications: Although this research found significant differences between older and younger fraud victims' characteristics, target suitability and capable guardianship must be further investigated and conceptualized when applying routine activities theory for online fraud against older people.

KEYWORDS

cyber routines, capable guardian, older adults, victimization, online fraud, routine activities theory, scam

1. Introduction

Older individuals become increasingly vulnerable to online fraud with their daily routines migrating to online platforms. Burnes et al. (2017), in a meta-analysis of 12 studies involving 41,711 individuals, found that online fraud affects approximately one in every 18 cognitively intact, community-dwelling older adults a year. The overall prevalence of elder financial fraud across studies was 5.6% up to 5 years and 5.4% up to 1 year. Financial fraud victimization is associated with severe financial, physical, and mental health consequences, including major

depression, generalized anxiety disorder, lower subjective health ratings, increased somatic complaints (Ganzini et al., 1990), premature mortality, and greater hospitalization (Dong and Simon, 2013; Burnett et al., 2016). In addition, most fraud-scam victims report anger, stress, regret, embarrassment, sadness, helplessness, and shame (FINRA, 2016). Older adults lost an estimated $1 billion (IC3, 2020) to online fraud in an age when loss recovery is difficult, and financial savings would be necessary to cover health insurance. Burnes et al. (2017) estimate that elder fraud/scam cases will double over the next two or three decades due to older adults' population growth.

In this study, we define online financial fraud/scam as intentionally deceiving a victim by misrepresenting, concealing, or omitting facts about promised goods, services, or other -- physical, mental, or emotional -- benefits that are nonexistent, unnecessary, or deliberately distorted for monetary gain (adapted from Titus et al., 1995; Beals et al., 2015b). Financial fraud differs from financial exploitation/abuse that is committed by caregivers or other trusted individuals (Hall et al., 2016). Our knowledge about elder financial fraud is mainly limited to elder financial abuse. However, little is known about seniors' specific situational and sociodemographic risks of falling for financial fraud/scams (Burnes et al., 2017). Our study aims to fill that gap.

Despite its severe effects and prevalence, fraud targeting older adults has not yet been studied extensively from a social context point of view, partly because of the inaccessibility of older age groups. In addition, among the works that study financial fraud victimization of older individuals, financial exploitation fraud by caretakers and financial fraud by strangers are often studied together, resulting in general findings. Furthermore, these studies do not include cases where perpetrators only interacted with victims online or by phone (Burnes et al., 2017; DeLiema, 2018). On top of that, the relationship between social context variables (demographics, living arrangements, job market activity) has not been revealed. This is a consequence of the lack of available data on the sociodemographic characteristics of the victims (DeLiema, 2018; Whitty, 2019). Thus, the current study focuses on victim demographics and situational circumstances, revealing unique findings of risk and protective factors for older victims, compared to younger victims, utilizing routine activity theory.

2. Theoretical framework: routine activities theory

Routine activities theory (RAT; Cohen and Felson, 1979) suggests that an individual's daily activities contribute to victimization. Cohen and Felson (1979) posit that an individual's social roles and social class influence their lifestyle, including risky activities resulting from individual rational choice. They suggest that a crime will likely occur if (1) a suitable target, (2) a motivated offender, and (3) the absence of a capable guardian spatio-temporarily converge. All three must come together in order for criminal activity to be realized. However, according to Cohen and Felson (1979), the motivated offender is everywhere, awaiting the opportunity to engage in criminal activity. Thus, research should concentrate on the victims' routines instead.

RAT has been initially developed to study victimization of predatory and property crimes (Cohen and Felson, 1979; Felson, 1986; Miethe et al., 1987; Massey et al., 1989; Sherman et al., 1989; Kennedy and Forde, 1990; Roncek and Maier, 1991), Newman and Clarke (2003) applied the model to cyberspace. They argued that online presence alone could make people suitable targets since they publish personal information as valuable assets online. Subsequent research found evidence for RAT in computer-crime (Kowalski, 2002; Moitra, 2005; Choi, 2008) and internet-crime victimization (Choi and Lee, 2017; for a summary see Leukfeldt and Yar, 2016). These studies posit that cyberspace provides ideal opportunities to commit crimes, as targets are digitally connected with multiple devices, working, studying, networking, and gaming online. Thus, all who are digitally connected suitable targets of online crimes. In the integrated cyber-RAT Choi (2008) asserts that motivated cybercriminals can easily find suitable targets in the form of online users who engage in online activities without applying adequate computer security measures or sharing their data on social networks (Yar, 2005). Computer security measures such as anti-virus software, web camera cover, or credit card monitoring function as capable (technical) guardians, and absence of them increases offending opportunities (Leukfeldt and Yar, 2016; Hawdon et al., 2020). At the same time, the level computer familiarity and computer skills can affect target suitability (Bossler and Holt, 2009). For instance, Choi (2008) tested target suitability studying risky online routine activities such as user willingness to visit unknown websites, downloading free MP3 files or free software programs, and clicking on icons without precaution on a sample of college students ($n = 204$). The study measured digital capable guardianship through the application of antivirus programs, antispyware, and firewall programs. Online lifestyle variables, such as online vocational and leisure activities, online risky leisure activities, and online risky vocational activities, have been used to measure the suitable target component. Choi (2008) concludes that online lifestyle activities contribute to the potential for computer crime victimization.

The current study proposes an extension of the measures of capable guardianship and target suitability to measure RAT applicability in financial fraud. Specifically, we propose that the presence of social (capable) guardians, such as relatives, can provide protection against financial fraud/scams targeting older individuals. We also suggest that victims' sociodemographic characteristics – such as education level, employment status, and asking for help after the initial fraud victimization – also influence target suitability. By including these new measures in the analysis, we suggest extending the list of measures in capable guardianship and suitable target, therefore, updating RAT measures to study financial scam victimization. In addition, we propose age-dependent characteristics of these measures presuming they work differently for older and younger age groups. In the following, we review scientific literature in RAT and older individuals' financial fraud victimization. Then, we describe the sample and methods applied in the current study, present the results, and discuss the findings of the current study considering the literature. The paper concludes with policy and future research recommendations.

3. Literature review. Older people's target suitability and the lack of capable guardians

Although older adults' overall crime victimization is lower than that of the younger ones (Carcach et al., 2001; Graycar and James, 2001; Holtfreter et al., 2014), out of the crime that older people experience, fraud is the largest category (Temple, 2007; Smith and

Budd, 2009). Gamble et al. (2014) associate financial fraud victimization of older Americans with decreasing cognition, overconfidence in one's financial knowledge, and willingness to take financial risks relative to non-victims. But even among older adults without cognitive impairment, age-related changes in cognition are associated with the declining ability of decision-making, thus, greater susceptibility to financial fraud (Boyle et al., 2012). Holtfreter et al. (2014) conducted telephone interviews on consumer fraud with 2,000 Arizonians and Floridians over 60. Fraud victimization was relatively low, with approximately 14% past-year prevalence. Being male, engaging in remote shopping, having low self-control (impulsivity), having a higher level of education, and telemarketing purchases increased fraud *targeting* (attempt to defraud the individual); remote shopping/purchasing, low self-control, being older, and minority status increased (actual) fraud *victimization*.

Older adults can downplay cognitive deficits to maintain financial independence (Deevy and Beals, 2013). Many victims never report their victimization and even hide it from family members and caretakers for fear of being blamed (Cross, 2016). That results in capable guardians (i.e., relatives, family members) not being able to step in before a greater amount of financial loss manifests. It also results in underreporting of financial fraud victimization relative to other age groups (Beals et al., 2015a). Underreporting not only distorts data on fraud victimization (Burnes et al., 2017) and limits our understanding of older people's fraud victimization but also hinders the development of prevention programs and policies focusing on age-appropriate needs (DeLiema, 2018).

Few studies have tested RAT on older people's cyber fraud victimization. Hutchings and Heyes (2009) concluded that computer use predicted receiving a phishing email. Reisig and Holtfreter (2013) tested the theory on remote purchasing fraud among adults 60 or older. They found that older adults who engage in remote purchasing activities face a greater risk of being targeted by fraud. Lower self-control also increased the risk of fraud victimization (Holtfreter et al., 2008; Reisig and Holtfreter, 2013). Pratt et al. (2010) examined the influence of routine online activities on Internet fraud targeting. Before controlling for time spent online and online shopping/purchasing behavior, younger and more educated consumers were significantly more likely to experience Internet fraud targeting (i.e., the attempt to defraud). But these effects disappeared after controlling for time spent online and online purchasing, and both of these behaviors significantly increased the odds of Internet fraud targeting, a finding that lends support to routine activities theory.

Although situational factors have been examined, few studies have indicated the significance of sociodemographic information in impacting or determining online fraud victimization of older adults. DeLiema (2018) adapted RAT to older individuals' financial fraud victimization. The model suggests that aging individuals will be most vulnerable to fraud during the period of declining cognitive and physical functioning when these deficits are hardest to recognize by capable guardians such as family members or medical professionals (DeLiema, 2018, p. 708). The American Association of Retired Persons surveyed 745 telemarketing fraud victims over 50 in 1995 to develop a profile (AARP, 1996). Although victims were generally socially integrated, they were more likely to live alone than their age group of older Americans in general and also less likely to seek advice on financial matters than non-victims. Social isolation is considered to be a risk factor in financial fraud (Fenge and Lee, 2018) because it is associated with loneliness, as isolated persons can be more receptive to answering the calls of unknown telemarketing callers (Langenderfer and Shimp, 2001), doorstep sales, and scam mails, and listen to sales pitches (Lee and Geistfeld, 1999) simply for the opportunity to talk to someone.

Furthermore, the proxy of caring relatives can provide external control. DeLiema (2018) extracted data from 53 fraud and financial exploitation cases, drawn from a pool of 924 cases presented between 2006 and 2013. She found that significantly more fraud victims – victimized by predatory strangers – were childless and had no relatives nearby compared to financial exploitation victims – victimized by trusted family members and relatives. Fraud perpetrators took advantage of elders when they had no trusted relatives or friends to safeguard their assets. On the other hand, elder fraud victimization occurred most likely when the victim only had mild cognitive or physical functioning impairment, and their behavior had not yet alerted relatives and friends to step up as capable guardians. Pratt et al. (2010) found that demographic characteristics such as gender, age, education, and marital status shape routine online activities, and indicators of routine activities, such as hours spent online, and online purchasing activity mediate the effect of demographic characteristics on the likelihood of being targeted by cyber fraud. In another study, Reyns (2015) examined whether online activities increased the risk of online victimization. Individuals active in online shopping, social networking, and posting information online were more likely to be victimized by phishing, hacking, and malware. Surprisingly, online technical guardianship was negatively correlated with online victimization: those who installed antivirus software were more likely to become victims. However, victims might have installed the software after being victimized. Therefore, Reyns (2015) suggests further studying online activities, guardianship, and victimization.

Whitty (2019) developed a susceptibility theoretical framework by including personality and sociodemographic characteristics, exposing online activities, risky online spaces, and online guardianship behaviors. One explanation for why educated people are more likely to be scammed is that highly educated people have a more robust online presence and frequent more online spaces than lower-educated people. Another possible explanation derives from the work of Lea et al. (2009), who suggest that overconfidence in recognizing scams places people at greater risk of becoming scammed. Educated people might have a false sense of security and spend less effort finding manipulation cues. Whitty (2019) also found that online guardianship behaviors, such as seeking advice on fraud information sites (Federal Bureau of Investigation, Federal Trade Commission), did not protect people from being victimized. Overall, research findings highlight the need for further studying the connection between online routines, guardianship, and online victimization.

Having a job means financial security, but it also means more financial assets to lose. The COVID-19 pandemic led to significant job losses. In the meantime, computer-assisted and online work became the norm instead of an exception. Individuals' online presence increased because of public health-related lockdowns and remote working conditions. So far, a few studies have examined the connection between lockdowns and online victimization (Hawdon et al., 2020). Kennedy et al. (2021) surveyed over 2,200 American adults to investigate their experiences with COVID-19-related fraud. People who considered themselves targets of fraud were almost 10 years younger, significantly more likely to be male, non-White,

possess a Master's or Doctoral degree, be single/never married, be employed and have a higher salary. Although the study did not look at the age differences of targeted/victimized persons, it highlights the risk factors posed by having a full-time job and living alone, suggesting that employment and the absence of family members or relatives as informal capable guardians increase the stakes of experiencing a financial loss (see also Kennedy et al., 2021).

In the present study, we have looked at situational and demographic characteristics of victims to investigate what makes older adults suitable targets for online scams and the potential protective factors, such as capable technical and nontechnical guardians. Considering previous research findings, we hypothesized that older victims differ in characteristics from younger victims. We break down these characteristics as follows:

> *H1 – Older individuals who are more bound to the computer in their daily routines and more familiar with the computer (overconfidence) will be more likely victims of online fraud than younger adults with similar suitable target characteristics.*
>
> *H2 – The presence of trusted relatives as social capable guardians protects older adults from online fraud*. Thus, those older individuals who live alone, without a partner or grown-up children, are more likely to be victimized than those who live in different living arrangements since the presence of relatives/family members can function as capable guardians.
>
> *H3 – Older victims are less likely to report and ask for help than younger victims*. We conceptualize reporting or asking for help as a form of gaining knowledge about financial scams, which could potentially lower the level of target suitability by successfully avoiding scams in the future.
>
> *H4 – Having a full-time job makes older people more prone to online victimization than retired individuals*. We assumed that full-time jobs provide more computer access than part-time jobs and unemployment.

In the next section, we introduce the sample, describe the variables utilized to measure suitable targets and capable guardians, introduce and discuss the results by comparing younger and older victims' characteristics and risk factors of falling victim to typical online fraudulent scenarios. Finally, we interpret the results in light of previous research. Finally, we conclude with policy and research recommendations.

4. Methodology

4.1. Analytical strategy

After examining the relationships between the dependent and independent variables, Fisher's Exact test was used because there were two dichotomous variables in our crosstabulations, e.g., whether the respondent used email (yes = 1; no = 0) and the victim was young (0) or old (1), and there were too few items in the subsamples. The Kolmogorov–Smirnov test of normality was utilized to assess the distribution level because the sample was greater than 2,000 (Lopes, 2011). Since the Kolmogorov–Smirnov test proved that the distribution of variables was not normal, non-parametric tests followed. As such, Mann–Whitney U tests were performed to compare younger and older participants' victimization in relation to routine activities theory (Figure 1). Mann–Whitney U tests are frequently used in clinical trials (Hart, 2001; Tai et al., 2022), as an alternative to a *t* test when the data are not normally distributed (i.e., skewed), as was in our sample. Aligning with the requirements (Nachar, 2008), we applied non-parametric tests, statistical methods based on signs and ranks, for multiple reasons: (1) the combined distribution of the variables was not normal; (2) where subsamples were compared (young victims, older victims, young non-victims, older non-victims); and (3) the low number of items did not allow the use of parametric tests. In addition, (4) the measurement level suggested utilizing non-parametric tests since parametric procedures cannot be applied to ordinal variables where the mean ratio cannot be interpreted (Kitchen, 2009; Nahm, 2016). To further analyze the differences between younger and older age groups along with victimization and non-victimization (four different groups, Table 1), we utilized Kruskal-Wallis H tests which can be applied when the variable of interest is not normally distributed and when there are three or more groups in the analysis (Bewick et al., 2004; Ostertagova et al., 2014). Thus, utilizing the SPSS 27 software package, we applied non-parametric tests such as the Mann–Whitney U test instead of two-sample t-tests, the Kruskal-Wallis H test instead of one-way ANOVA, and Spearman correlations for variables with ordinal level of measurement instead of Pearson correlation (Analytical strategy flowchart shown in Figure 1).

4.2. Participants

A national sample of 18 or older Americans ($n = 2{,}928$) was collected using Dynata and Qualtrics research panels in October 2020. Dynata and Qualtrics are online market research companies offering to sample and field online surveys on samples representative of age, gender, race, and ethnicity. After deleting participants who sped through or failed to complete the survey, 2,589 items remained in the final sample. The mean age was 44.68 ($SD = 17.35$), ranging from 18 to 98 years. Overall, 48% of the sample was male, 50% female, and 0.7% non-binary, with 0.6% not answering. Regarding the highest level of education, 20% owned a postgraduate degree, 29% had a college degree, 23% some college, 23% high school, and 3% less than a high school diploma. The majority (74%) of the participants were White, 15% were Black, and 15% were of another race. Eight percent were still in school, 40% had a full-time job, 16% had a part-time job, 21% were unemployed, and 21% were retired. Twenty percent of the participants lived alone, 30% lived with a partner without children, another 26% with a partner and children, 7% were single parents, 9% were living with parents, and 7% lived together within other family types or other arrangements. Participant sociodemographic information can be found in Table 2.

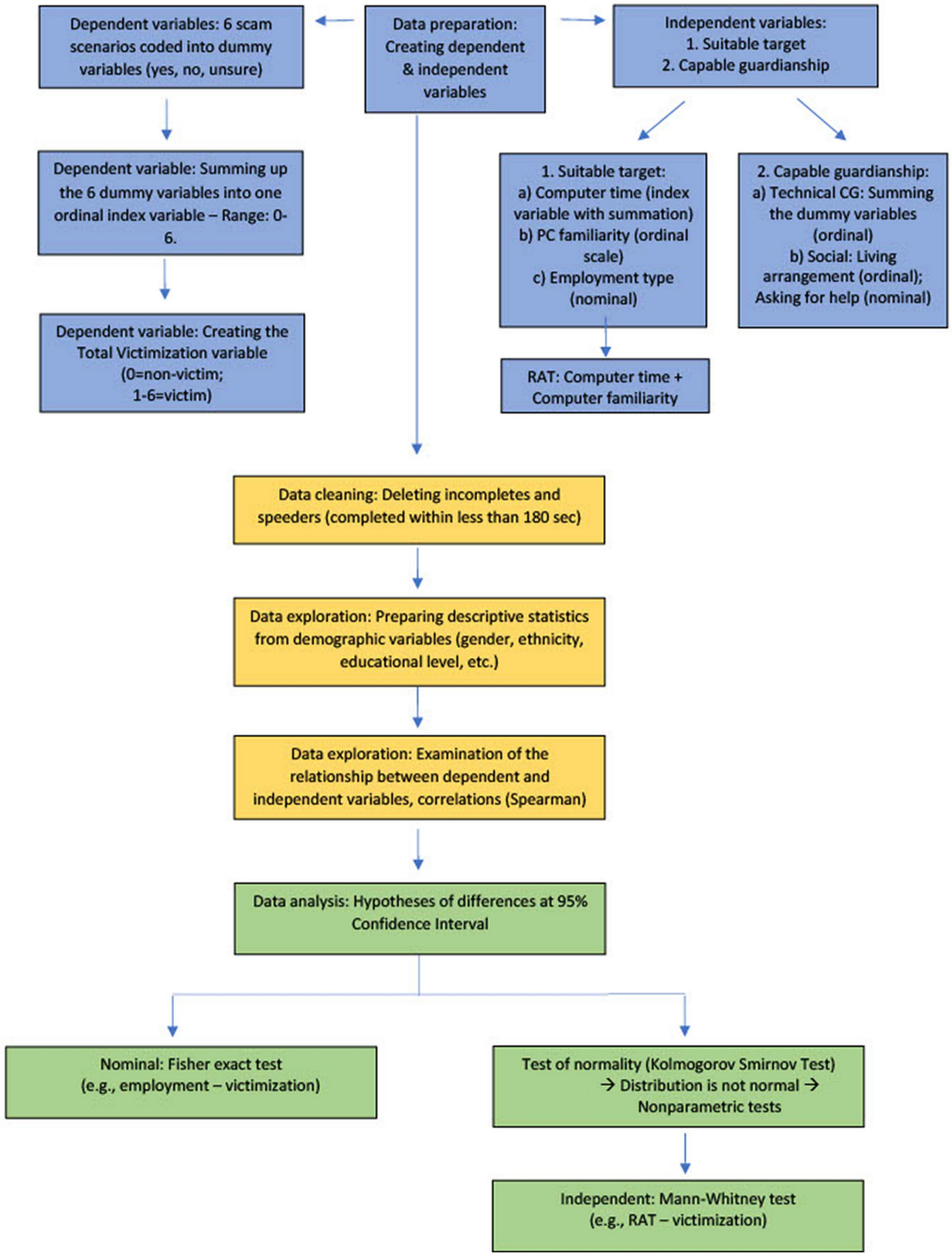

FIGURE 1
Analytical strategy flowchart.

4.3. Dependent variables

4.3.1. Online fraud types

We created multiple closed-ended questions describing specific fraud-scam events to measure financial fraud affectedness in the survey. This closed-ended and descriptive assessment leaves less room for participant confusion and improves the identification of financial fraud scenarios by cueing-activating memory recall (Deevy and Beals, 2013; Burnes et al., 2017). Using the Federal Trade Commission's fraud-scam taxonomy targeting older adults (Simons et al., 2020) and the FBI's "elder fraud" list (FBI, 2020) as baselines to determine typical

TABLE 1 Computer familiarity, PC time, and technical guardians, by victim and non-victim age groups.

RAT variables and victim age groups – Kruskal-Wallis test						
	Mean Ranks				Kruskal-Wallis H	*p*
	Victim group (18–54)	Victim group (55+)	Non-victim group (18–54)	Non-victim group (55+)		
Computer familiarity (How familiar would you say you are with computers?)	1410.47	1169.2	1306.97	1062.64	84.666	0.001
Technical Guardian – Currently in place	1499.13	1251.6	1034.44	1127.2	200.834	0.001
Technical Guardian – Put in place because of a prior victimization	1624.94	1171.51	1081.1	1039.83	461.785	0.001
RAT Scale (PC-time + Familiarity)	1270.19	1081.59	1192.42	934.44	83.535	0.001
Technical Guardian - Pairwise comparisons with Mann–Whitney test						
	Mean Ranks			Mann–Whitney U-stat	*p*	
Technical Guardian - Currently in place						
Victim group (55+) vs. Victim group (18–54)	513.71		644.45	114,910	$p < 0.01$	
Victim group (55+) vs. Non-victim group (55+)	432.03		388.14	70774.5	$p < 0.05$	
Victim group (55+) vs. Non-victim group (18–54)	636.85		531.6	106,473	$p < 0.01$	
Technical Guardian - Put in place because of a prior victimization						
Victim group (55+) vs. Victim group (18–54)	458.77		685.68	97285.5	$p < 0.01$	
Victim group (55+) vs. Non-victim group (55+)	440.04		395.48	73,299	$p < 0.01$	
Victim group (55+) vs. Non-victim group (18–54)	607.69		563.04	125,853	$p < 0.05$	

fraud scenarios targeting older Americans, we included six financial fraud scenarios, contextualizing with descriptive content: (1) Company impersonation: "In the past 12 months, did you get a phone call from a company that asked you to go to your computer and send them private information about yourself and/or your family members, and/or send them money?"; (2) Tech support scam: "Some scammers call people pretending they are from an IT company or personnel, asking to allow remote access to the computer, and once they are given access, they lock the owner out. Then they ask for credit card details to repair the owner's computer. In the past 12 months, did you experience the above scenario?"; (3) Grandparent scam: "Some scammers call people pretending they are their grandchildren, asking for money to solve some unexpected financial problem (overdue rent, payment for car repairs, bail, etc.). At the same time, the caller begs, "please do not tell my parents." In the past 12 months, have you received a call from such a scammer?"; (4) Personal data verification scheme: "In the past 12 months, have you received email from a seemingly legitimate company or institution (e.g., IRS, bank, etc.) asking you to "update" or "verify" your personal information via email or on the website provided by the email?"; (5) Advance fee fraud: "In the past 12 months, have you received a call or email according to which you are required to send money to someone so that at the end of the cycle (when everyone pays a certain amount of dollars) you receive a greater amount of money?"; (6) Romance scam: "In the past 12 months, have you been asked by someone you met on an online dating platform to send them money or other donations (e.g., plain tickets, travel expenses, etc.) or finances (e.g., pay for surgery or other medical expenses, pay custom fees to retrieve something, pay off gambling debts, pay for visa or other official travel documents, reload cards or gift cards)?" The answer options for all six fraud scenarios were yes (1), no (0), and unsure. "Unsure" answers were later recoded as missing values for ambiguity and to be able to dichotomize variables. An additional screening question asked whether participants were financially victimized because of being *targeted* by scammers. Only those who answered "yes" were included in the analysis.

4.4. Independent variables

4.4.1. Suitable target

Several variables representing suitable target and capable guardian RAT measures were included in the survey. Suitable target measures were conceptualized by computer time, computer familiarity, and employment type. Computer (PC) time (computer-related activity) was measured with a time scale (hours): "In a typical week, how many hours do you spend:" "Playing video games;" "Reading news or other articles online;" "Browsing social media like Facebook, Instagram, Twitter, etc.;" "On a computer, while working at a job;" "Shopping online;" and "Other online activities." Computer familiarity was

TABLE 2 Total sample (*N*=2,589) demographics.

Gender	Male	Female	LGBTQ/ Non-Binary	No Answer			
	1,242 (48%)	1,295 (50%)	18 (0.7%)	15 (0.6%)			
Education	Less than High School	High School	Some College	College Degree	MA/Professional/ PhD		
	73 (3%)	606 (23%)	605 (23%)	759 (29%)	527 (20%)		
Race	White	Black	American Indian	Asian	Pacific Islander / Hawaiian	Other/Prefer not to Answer	
	1905 (74%)	386 (15%)	74 (3%)	151 (6%)	18 (1%)	128 (5%)	
Age	Mean	Median	SD	Min	Max		
	44.68	42	17.35	18	98		
Employment	In school	Full-time job	Part-time job	Unemployed	Retired		
	204 (8%)	1,047 (40%)	415 (16%)	552 (21%)	535 (21%)		
RAT – PC time	Mean	Median	SD	Min	Max		
	28.48	20	26.24	0	246		
RAT – Computer familiarity	Uncomfortable	Surf the net	Fix some problems	Fix most of the problems	Programming		
	260 (10%)	733 (28%)	744 (29%)	446 (17%)	1,392 (15%)		
RAT – Technical Guardian	Cover the web camera 1,162 (44.9%)	Identity theft protection 1,118 (43%)	Freeze credit card 761 (29%)	Antivirus/Firewall 1,649 (64%)			
RAT – Living arrangement	Living alone 512 (20%)	Living w partner, no children 787 (30%)	Living w partner and children 672 (26%)	Single parent 189 (7%)	Living with parents 236 (9%)	Other family type 147 (6%)	Other arrangements 25 (1%)

assessed by a five-point ordinal scale ranging from "I am uncomfortable using a computer;" to "I am comfortable manipulating or writing computer programming." Employment type was a nominal scale with the options "in school," "paid full-time job," "part-time job," "unemployed," and "retired." Respondents could mark one of these options that best describe their employment status.

4.4.2. Capable guardianship

Capable guardianship was measured by applying technical guardians, such as antivirus software, and nontechnical/social guardians, such as living arrangement and asking for help. Technical guardianship was assessed by dichotomous answer categories to the following statements: "Cover your webcam on your computer or laptop;" "Use identity theft protection monitoring;" "Freeze your credit when you do not plan to use;" and "Use virus software and/or firewall on your computer." Similarly, asking for help was assessed on a dichotomous scale: "If you witnessed one or more of the above scenarios, who did you ask for help?" where participants could check multiple answers (Table 2). We conceptualize living arrangement as capable guardianship. Studies refer to marriage and children as informal guardians that can protect individuals from victimization (Lee and Geistfeld, 1999; Langenderfer and Shimp, 2001; Fenge and Lee, 2018; Kennedy et al., 2021). Following previous studies (DeLiema, 2018), we assumed that adult relatives (e.g., partners and grown-up children) could function as informal capable guardians. Table 2 shows details and breakdowns of independent variables.

4.5. Control variables

This study used age as a control variable. Studies vary about determining the age of "older adults" when it comes to victimization. Some employed 50 (Lichtenberg et al., 2013, 2016), 55 (Federal Trade Commission, 2003; Pak and Shadel, 2011), 60 (Reisig and Holtfreter, 2013; Holtfreter et al., 2014), and 65 (Titus et al., 1995; AARP, 1999; Anderson, 2004, 2007, 2013; Holtfreter et al., 2006; Harrell and Langton, 2013; Harrell, 2015; Burnes et al., 2017; DeLiema, 2018; Fenge and Lee, 2018) as age cutoffs. We applied the age of 55 as a dividend between "younger" and "older" adults (<55 and >=55), hoping that more items in the sample of "older" adults will provide more generalizability. In addition, the computer became an integrated part of education in the mid-1980s, while the internet became a tool of mass communication not earlier than the mid-1990s (Molnar, 1997; Parker and Davey, 2014). Thus, people over 55 have not yet had computers and the internet as part of their everyday lives while growing up. This creates a generational gap between younger and older adults (Prensky, 2001). Younger adults have used computers and the internet as a necessity. In contrast, older individuals had to attain digital literacy later in life, and consequently, they might have more difficulties detecting online scams.

Victims under 55 comprised 35.3% (n=915), and victims 55 and older made up 12.9% (n=334) of the total sample (n=2,589). Older victims generally attained higher education levels than younger ones: 58.4% of older victims had some college or college degrees, compared

to 48.8% of younger victims. Employment differences turned out in the expected direction, with 55.96% of younger and 22.5% of older victims having full-time jobs, and 58.1% of older victims and 2.19% of younger victims being retired. Younger victims applied technical guardians at a higher rate than older victims, except for antivirus/firewall, which older victims applied at a higher rate (79.8%) than younger victims (65.9%). Computer familiarity showed a diverse picture, with a higher proportion of older victims having confidence in their basic computer skills (surfing and fixing some problems) than younger victims. However, younger victims had more confidence in programming (24.6%) than older ones (6.0%). Mean PC-time was higher ($M = 30.6$ h per week, $SD = 27.3$) for younger victims than older victims ($M = 25.7$ h per week, $SD = 19.9$). As expected, more older victims lived alone or with a partner, having no children around (79.6%) than younger victims (37.9%). For a between-group comparison of victim characteristics, see Table 3.

5. Findings

We created the "total victimization" variable considering the six fraud schemes included in the analysis. Respondents who answered "yes" to 1–6 scam scenarios were "victims" (1–6), and only if answered "no" to all the scams were "non-victims" (0). This variable forms the basis for the victim/non-victim groupings (e.g., older victims: any person 55 years of age and above who has been a victim of at least one of six scams; Table 3). Corroborating previous research results, the data suggest that older individuals are being victimized by any online fraud at a lower rate (40.4%) than younger ones (52.8%), with personal data verification, company impersonation, tech support scam, advance fee fraud, romance scam, and grandparent scam being the most frequent in rank for younger victims. The rank is similar for older victims, with grandparent scams being a little more frequent than romance scams. Despite having slightly different ranks, the prevalence of scams in the older victim group does not show a remarkable divergence compared to younger victims.

We hypothesized that older victims would differ in characteristics from younger victims*: H1 – Older individuals with more computer-intensive daily routines and who are more familiar with computers will be more likely victims of online fraud than younger adults.* To test this hypothesis, we created the PC-time and the computer familiarity variables so that the original interval scales were converted into ordinal level scales by the method of visual binning. Next, we merged the PC-time and the computer familiarity variables into a single new variable (RAT variable), an ordinal scale ranging from 2 to 10 (Table 1). As it is shown in Table 1, those who fell victim to any online scams were more familiar with computers than non-victims, both in the young (M $rank_{victims}$: 1410.47, M $rank_{non\text{-}victims}$: 1306.97) and the older group [M $rank_{victims}$: 1169.2; M $rank_{non\text{-}victims}$: 1062.64; $H(3) = 84.666$; $p < 0.001$]. The RAT scale (the merged computer familiarity and PC-time variable) showed a similar pattern: young people were more likely victimized than older adults, but victims, young and old, ranked higher in the RAT scale (young victims: 1270.19; old victims: 1081.59) than non-victims [young non-victims: 1192.42; old non-victims: 934.44; $H(3) = 83.535$; $p < 0.001$]. Therefore, the numbers corresponded with our first hypothesis.

Further analyzing the data, when it came to applying technical guardians (merged 0–4 scale variable from covering webcam, identity theft monitoring, freezing credit cards when not planned to use, and antivirus software/firewall), the victim groups ranged higher than the non-victim groups, independent of age [$H(3) = 200.834$; $p < 0.001$]. This means that victims applied more technical guardians than non-victims. However, younger victims were significantly more likely to put technical guardians in place as a result of previous victimization (M $rank_{yv}$: 685.68) than older victims (M $rank_{ov}$: 458.77; $U = 97285.5$; $p < 0.01$; Table 1). This detail refined our understanding of how much technical defensive techniques (or capable guardians) age groups tend to apply in order to fend off revictimization.

H2 – We further assumed that those older individuals who live alone, without a partner or children, are more likely will be victimized than those who live in different living arrangements. To test this assumption, we used the total victimization variable (see Table 3), then we made pairwise comparisons between living arrangements within the older victim group with Mann–Whitney U tests. Contrary to the expectations, those who were single parents were significantly less likely to be victimized than those who lived in any other living arrangements ($U = 8851.000$; $p = 0.033$), including those living with a partner and children ($U = 839.000$; $p = 0.016$; Table 4).

H3 – Older victims are less likely to report and ask for help than younger victims. When it comes to asking for help or reporting, older victims (64.10%) were indeed significantly more likely than younger ones (14.00%) to have said that they did not reach out to anyone ($p = 0.001$). Apart from reporting to the Federal Trade Commission or to the same person who contacted the victim, all report options showed statistically significant differences per age group: younger victims were more likely than older victims to report to the IT personnel or team ($p = 0.001$), to a civic organization ($p = 0.001$), a lawyer ($p = 0.001$), a family member ($p = 0.027$), and a living facility administrator ($p = 0.034$; Table 4).

H4 – Having a job makes older people more prone to online victimization than retired individuals. First, we compared full-time employee and retired victims within the older victim group. According to the results, having a full-time job indeed made older victims more prone to online fraud victimization when it comes to company impersonation scams (Fisher $p = 0.032$), grandparent scams (Fisher $p = 0.007$), advance fee fraud (Fisher $p = 0.002$), and romance scams (Fisher $p = 0.001$). The difference between full-time employed and retired older victims was most remarkable in advance fee fraud and romance scams. No statistically significant relations were revealed in tech support and personal data verification scams (Table 4). In a second step, we wanted to see specifically whether older individuals with computer-related job activities are more likely to be victimized than younger individuals with computer-related jobs. This time, we measured age-group differences of all participants with a full-time or part-time job who indicated at least an hour of computer use while at work ($n = 1{,}051$). The Fisher test showed a statistically significant relationship between using a computer while at work and being victimized for all types of online fraud. However, younger individuals with computer-related vocational routines were significantly more likely to be victimized by any scam than older individuals (Table 4; Figure 2).

TABLE 3 Victim and non-victim demographics and routine activity theory measures by age group.

Victim characteristics	Victims 18–54 (*N* =915)		Victims 55 and above (*N* =334)	
Gender	*N*	Group %	*N*	Group %
Male	490	53.7%	197	59.2%
Female	409	44.8%	133	39.9%
LGBTQ+	12	1.3%	2	0.6%
No answer	4	0.4%	2	0.6%
Race (multiple answers)				
White	644	70.4%	299	89.5%
Black or African American	180	19.7%	11	3.3%
American Indian or Alaska Native	34	3.7%	6	4.5%
Asian	47	5.1%	14	1.8%
Native Hawaiian or Pacific Islander	13	1.4%	0	4.2%
Other	35	3.8%	9	2.7%
No answer	4	0.4%	0	0.0%
Education				
Less than a high school diploma	17	1.9%	2	0.6%
High school degree	194	21.2%	55	16.5%
Some college	186	20.4%	78	23.4%
A college degree	260	28.4%	117	35.0%
A master's degree or higher	257	28.1%	82	24.6%
Employment				
In school	100	10.93%	3	0.9%
Full-time job	512	55.96%	75	22.5%
Part-time job	200	21.86%	39	11.7%
Unemployed	204	22.29%	31	9.3%
Retired	20	2.19%	194	58.1%
RAT – Computer familiarity				
Uncomfortable	118	12.9%	27	8.1%
Surf the net	181	19.8%	113	33.8%
Fix some problems	220	24.0%	117	35.0%
Fix most of the problems	171	18.7%	57	17.1%
Programming	225	24.6%	20	6.0%
RAT – PC-time				
Mean	30.6		25.7	
Median	21		21	
SD	27.3		19.9	
Min	0		0	
Max	246		129	
RAT – Technical Guardian				
Cover the web camera	605	66.5%	107	32.2%
Identity theft protection	481	53.3%	158	47.6%
Freeze credit card	413	45.9%	83	25.0%
Antivirus/Firewall	595	65.9%	265	79.8%
RAT – Living arrangement				
Living alone	138	15.1%	87	26.0%

(Continued)

TABLE 3 (Continued)

Victim characteristics	Victims 18–54 (*N* =915)		Victims 55 and above (*N* =334)	
Gender	*N*	Group %	*N*	Group %
Living with partner no children	208	22.8%	179	53.6%
Single parent	78	8.6%	6	1.8%
Living with partner and children	365	40.0%	38	11.4%
Living with parents	75	8.2%	4	1.2%
Other family type	40	4.4%	19	5.7%
Other arrangements	8	0.9%	1	0.3%
Victimization	N	% of age group	*N*	% of age group
1. Company impersonation	549	31.7%	116	14.0%
2. Tech support scam	485	28.0%	104	12.6%
3. Grandparent scam	396	22.9%	51	6.2%
4. Personal data verification	602	34.8%	225	27.2%
5. Advance fee fraud	426	24.6%	67	8.1%
6. Romance scam	401	23.2%	39	4.7%
Total (any of the above)	915	52.8%	334	40.4%

6. Discussion

Despite its prevalence and relatively serious consequences, fraud against older people has not yet been studied extensively in a social context. The works tend to focus on financial exploitation of older adults by caretakers, but financial fraud by strangers is often missed out from the analysis. In addition, studies do not include cases where perpetrators only interacted with victims online or by phone (Burnes et al., 2017; DeLiema, 2018). Furthermore, the role of social context variables (demographics, living arrangements, job market activity) in online fraud victimization has not been revealed yet, because of the lack of available data on victims' sociodemographic characteristics (DeLiema, 2018; Whitty, 2019). The present study aims to fill these above gaps by looking at situational and demographic characteristics of older fraud victims to investigate what makes older adults vulnerable to online scams and what the potential protective factors are. The current study's novelty is that, by focusing on demographics and cyber victimization factors, it reveals unique findings of risk and protective factors for older victims, compared to younger victims, utilizing routine activity theory (Cohen and Felson, 1979). The paper test routine activities theory to compare the differences in online fraud vulnerabilities of younger victims aged 18–54 and older victims of 55 and above. In addition to computer time and computer familiarity, we included independent variables such as living arrangement, employment, and reporting fraud or asking for assistance in the analysis. We assumed that older fraud victims differ in situational and sociodemographic characteristics from younger fraud victims. We investigated the differences that function as risk or protective factors utilizing non-parametric statistical tests such as Mann–Whitney U and Kruskal-Wallis H tests.

Our hypotheses were partly supported. People with more computer familiarity and computer-bound daily routines fell victims of scams on a greater level in both age groups, however, younger computer savvy individuals fell victim to scam scenarios still more likely than older ones with similar characteristics. In some cases (personal data verification and total victimization), the difference between the age groups was smaller. However, the difference was greater in company impersonation, grandparent scam, advance fee fraud, and romance scam. Interestingly, other than romance scam, which typically starts by contacting the targets on online social media or dating websites (Cross, 2020b), all scam types where older people had a higher chance of victimization typically started with a phone call from the scammers (The scam scenarios in the survey described how the scammer made the initial contact). This indicates that older people are more approachable by phone than younger people, perhaps because of their relatively low level of online presence compared to younger people. Holtfreter et al. (2014) also found that the telephone was the most common contact method for older people targeted for consumer fraud. On the other hand, this finding suggests that when approached via phone, older people were more likely than younger ones to believe the scammers, compared to email-initiated frauds (personal data verification scam and advance fee fraud in our survey) where the level of risk to be victimized was not so different in young and older adults.

Victims reported a higher computer skills level than non-victims in both age groups. However, older victims self-reported a significantly higher computer savviness than non-victims. To be precise, older people who fell victim to scams were less likely to be computer savvy than any young respondent, but more so than old non-victims. Perhaps cognitive biases such as overconfidence in computer skills (González et al., 2015) and the illusion of control (Thompson, 1999; Matute et al., 2015) are some reason older victims are more reluctant to apply simple technical guardians such as a webcam cover, identity theft monitoring, and credit card freeze, compared to younger victims, even after being scammed. This difference between young and old victims comes to light only after comparing the victim age groups since, in general, the older group reported a higher level of basic computer familiarity (surfing the net and fixing minor computer

TABLE 4 Employment type, and nontechnical guardians (reporting/asking for help, living arrangement) by victim age groups.

Employment and victimization; Older individuals – Fisher's Exact test (n=667)				
Victimization of age group 55+	Group %		Fisher p	
	Retired (n =493)	Full time job (n =174)		
1.Company impersonation	12.60%	19.50%	0.032	
2. Tech support scam	13.00%	15.50%	N.S.	
3. Grandparent scam	4.30%	10.30%	0.007	
4. Personal data verification	25.80%	31.60%	N.S.	
5. Advance fee fraud	5.70%	13.20%	0.002	
6. Romance scam	2.40%	11.50%	0.001	
Computer-related job and victimization; Younger and older individuals – Fisher's Exact test (n = 1,051)				
Victimization of those with computer-related vocational daily routines	Group %		Fisher p	
	Victim group (55+)	Victim group (18–54)		
1.Company impersonation	18.9%	42.5%	0.001	
2. Tech support scam	14,6%	39.2%	0.001	
3. Grandparent scam	11.4%	33.4%	0.001	
4. Personal data verification	32.4%	43.2%	0.008	
5. Advance fee fraud	14.6%	34.3%	0.001	
6. Romance scam	10.8%	34.7%	0.001	
Asking for help/Reporting; Younger and older victims – Fisher's Exact test (n = 1,249)				
Asking for help from whom?	Group %		Fisher p	
	Victim group (55+)	Victim group (18–54)		
The same people who contacted me	10.20%	14.10%	N.S.	
IT personnel or team	7.50%	18.40%	0.001	
Civic organizations	2.70%	7.70%	0.001	
Federal Trade Commission	6.60%	7.20%	N.S.	
Lawyer	1.80%	8.00%	0.001	
Family Member	8.40%	12.80%	0.027	
Living Facility Administrator	1.20%	3.30%	0.034	
Other	13.20%	2.10%	0.001	
No one	64.10%	14.00%	0.001	
Living arrangement and victimization - Pairwise comparisons with Mann–Whitney test				
Living arrangement (N = 826)	Mean Ranks		Mann–Whitney U-stat	p
Living alone vs. all other 55+	404.72	416.63	-	N.S.
Living w partner no children vs. all other 55+	421.53	405.11	-	N.S.
Single parent vs. all other 55+	330.61	416.41	8851.000	0.033
Living w partner, children vs. all other 55+	446.04	409.91	-	N.S.
Other family arr. vs. all other 55+	397.17	414.69	-	N.S.
Living w partner no children vs. living w partner, children	249.99	265.43	-	N.S.
Other family arr. vs. living w partner, children	64.8	72.71	-	N.S.
Single parent vs. Living w partner, children	44.46	59.27	839.000	0.016

problems) than the younger group. In addition, although older respondents' computer familiarity was lower than younger respondents' in computer programming, that is not the skillset one would need to recognize potential scams. Instead, people need more awareness of how scammers typically approach targets and perhaps more technical guardians to prevent victimization. However, the data corresponds that older victims not only tend to overestimate their computer skills but are also less likely to install essential technical guardians, even after being scammed than younger victims. The result was similar when we included PC-time (time spent on a computer

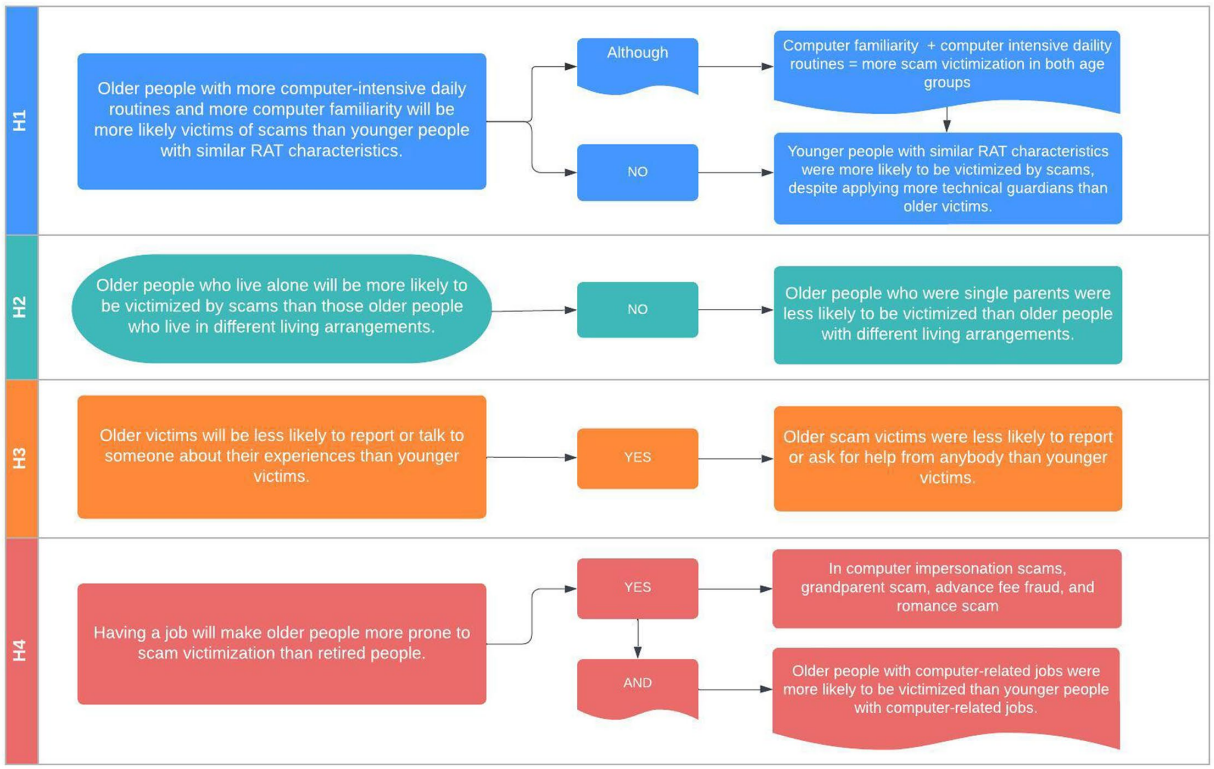

FIGURE 2
Results graphic.

daily) into the analysis: older victims' mean average time on a computer lags behind that of any younger respondents (victims and non-victims) but exceeds older non-victims' computer time. Thus, spending time on a computer, being (over)confident in computer skills, and lacking technical guardians all increase the risk of online fraud victimization for everyone, but it makes seniors more suitable targets than younger people.

We further conceptualized living arrangement and asking for help/reporting fraud as nontechnical guardians. Research indicates that loneliness and isolation make individuals more willing to answer unknown phone calls (Langenderfer and Shimp, 2001), and the presence of relatives and family members can function as an extra pair of eyes/ears that can prevent scams (DeLiema, 2018). In the current sample, however, quite unexpectedly, older people who were single parents significantly less likely fell victim to scams than older victims in other living arrangements. In addition, older single parents were significantly less likely to experience scams than older people with young children *and* a partner around. The question applies then, why does being a single older parent means protection against scams?

To better understand the context of single parenthood, we borrow the concept of "grandparenthood" (Dolbin-MacNab, 2019), according to which relative caregivers, such as grandparents, can serve as key sources of support within families. As society is aging, older people are more likely to serve as sole caretakers or guardians of grandchildren whose parents are perished, incarcerated, struggling with addiction or mental health issues, or where the parent is young or inexperienced in childrearing (Saxena and Brotherson, 2021). Other reasons for grandparenthood include unstable home life or parents' homelessness, lack of financial resources or general ability, domestic violence in the home, divorce, or military deployment (Hayslip and Kaminski, 2005). Research shows that custodial grandparents, adults who are caring for their grandchildren full-time, are becoming more prevalent. In 2000, 5.7 million grandparents lived with their grandchildren (Hayslip and Kaminski, 2005), and approximately 2.4 million individuals raised their grandchildren in the United States. In 2014, approximately 7.8 million (one in 10) children lived with 4.9 million grandparents (Generations United, 2014). Although we do not have information about the exact circumstances of single parenthood in our sample, we propose that "grandparenthood" can be a feasible explanation of less scam victimization. It is realistic that people above 55, who are sole guardians of young children, are extremely cautious not to enter any risky situations, including answering cold calls or jumping into risky winning schemes. They might intend to spend their income very carefully, especially if they are retired and live on a fixed income. Thus, single parenthood and fiscal shortages might function as capable guardians from financial fraud for older adults. However, future research must look into the details and context of how living arrangements can serve as a risk or protective factor in online scamming in the context of RAT.

Asking for help is never an easy task, but, according to our results, for older victims, it can be even more challenging than for younger ones. The results suggest that younger victims are significantly more likely to ask for help from anyone, except for reporting to the Federal Trade Commission, an agency accepting scam reports and quite well known by the American people. In contrast, older victims typically do not talk to anyone or report anywhere their scam experiences.

Curiously enough, family members were the least likely contacted by older victims among the options offered (lawyer, IT personnel, civic organization, living facility administrator, etc.). Unfortunately, our study did not ask *why* victims do not confide in family members and relatives. These questions are highly recommended to investigate in future research. Asking for help/reporting victimization could help reduce repeated victimization, thus being an essential prevention tool, and research should look at what role reporting (or the lack of it) plays in re-victimization of older people.

An additional characteristic of older victims is the type of employment. In our sample, older victims with full-time jobs were significantly more likely to experience company impersonation, grandparent scam, romance scam, and advance fee fraud than retired victims with no vocational routine activities. Although the scam scenarios we provided in the survey indicated that these same scams tend to begin with a phone call, most scams operate on a mixed utilization of phone and computer-based communication. Hence, after the initial telephone call, the target might be asked to go to the computer and continue communicating electronically, and a full-time job might provide more proximity to a computer. On the other hand, full-time employees' higher level of victimization might have to do with more confidence in spending money. This finding is in line with previous research suggesting that being confident in finances and having rich financial literacy skills are indeed risks of online fraud victimization (Fenge and Lee, 2018). Another possible explanation for the relatively more vulnerability of full-time workers in the older age group might be a false sense of security provided by the employer's computer system, not realizing that fraudsters tend to apply social engineering techniques that cannot be entirely prevented by technical guardians such as firewall or antivirus software. This detail is worth the attention, even though computer-related vocational routines more likely turned into risky daily lifestyle routines for younger than older individuals in this sample.

6.1. Limitations

In the current study, it was impossible to have an exact measure of capable guardians and online lifestyle/routine activities. In addition, content validity regarding computer familiarity, a self-assessment measure can be another concern. Perhaps it would be more adequate to measure computer skills by providing detailed descriptions. Furthermore, firewall and antivirus programs are nowadays included in modern computer operating systems; thus, measuring capable guardianship could be more valid by applying a detailed list of modern computer security programs that users can select.

The list of online manipulation schemes applied in the study is not complete. Online fraud constantly evolves, especially when offline communication is restricted due to natural emergencies such as the COVID-19 pandemic. Daily routine activities increasingly shift to online platforms as digital connectedness grows. Due to demographic, public health characteristics and relatively new connectedness, older adults represent an especially vulnerable age group. In addition, as older adults' online presence grows, the range of online manipulations is expected to emerge and expand (Cross, 2020a). Prevention programs and policies can never be comprehensive to tackle all versions of online manipulations. Still, research can help map the risks by providing more precise scales to study online victimization. Updating surveys regarding new online manipulation schemes is imperative to get a fuller picture of older adult victimization. In the future, it may be necessary to implement face-to-face interviewing to provide more opportunities for participants to share circumstances of victimization.

Furthermore, survey items must be designed in consultation with older adult victims of financial fraud in order to achieve measurement accuracy. Future elder fraud victimization studies should even include close proxy respondents (caretakers) to represent older adults with cognitive impairment that limit direct participation. Research suggests (Cross, 2016) that there is no common method of scamming, and thus, there is no universal explanation for fraud victimization. Instead, financial fraud can take many forms, and it is essential to apply case-based investigation. Since individuals with specific socio-economic backgrounds can be targets of different fraud types, each type of financial fraud should be studied individually.

Because of sample and data characteristics (Kitchen, 2009; Nahm, 2016), we utilized Mann–Whitney U tests to compare differences between the age groups considering victimization. However, this statistical test has its weaknesses. For instance, it requires lengthy calculations and is prone to human error. Furthermore, it does not explain which variable causes the difference between the groups (Nachar, 2008). Future research must be aware of these weaknesses and apply more appropriate samples and statistical tests to inspect group differences. The use of multilevel modeling in future analyses is, as well, would be recommended, to identify data hierarchies and residual components.

6.2. Practical and theoretical implications

The results suggest that older victims are more reluctant than younger ones to ask for help. Moreover, relatives and family members are the least likely to know about their loved ones' victimization. Therefore, close proxy individuals who take care of older adults should also be the focus of awareness-raising campaigns to learn more about early signs of financial fraud in order to avoid scams and help victims overcome their losses.

Older adults with full cognitive capacity may still be in the workforce, but they exhibit risk factors unique to them, such as better financial situations (savings and assets), more confidence in handling large investments, and lacking formal and informal capable guardians (i.e., not applying technical tools, not having somebody in close proxy to confide in). Employers should address the unique vulnerabilities of the aging workforce by providing age-appropriate financial fraud prevention programs tailored to their needs. Perhaps it is time for employers to realize that technical guardians are not meant to protect workers fully. Instead, sophisticated online frauds psychologically manipulate victims to give out their valued assets. Awareness programs must cover social engineering techniques, how con artists target and manipulate victims, and make it clear that it can happen to everyone, regardless of age. Realizing the everyday nature of scams can provide confidence to victims to report or ask for help so that scams will likely be avoidable for them in the future.

6.3. Future research directions

The current study tested online fraud victimization from a sociodemographic and routine activities' perspective; however, it did

not include victims' personal characteristics in the analysis. The mixed results of the study suggest that online and telephone fraud victimization is a more complex issue and underlying measures must be responsible for victimization and protection. Therefore, the role of sociodemographic characteristics and personal measures should be further studied in the scam victimization of older ages. For example, Whitty (2019) suggests that impulsivity and self-control measures should be part of the analysis because victims tend to act out of urgency and sensation -- in seeking a job opportunity, a lucrative investment, or an item to purchase. The effects of personal characteristics on victimization can be amplified due to the pandemic, when the recent loss of close relatives, sudden unemployment, or other kinds of financial hardship impacts common sense of careful judgment. Furthermore, additional factors such as age-related changes in cognition may mediate scam vulnerability of even older age groups (Boyle et al., 2012). Future studies must examine how these factors, combined with individuals' daily routines and missing capable guardians, influence scam vulnerabilities of older people. The risk and protective factors should be also examined separately in younger and older retired individuals, so that characteristics of victims 65 and above can be identified. Although there is a staggering number of scam victimization reported (FBI, 2020), researchers know less about unreported scams that may or may not result in money loss, but likely inflicts emotional struggle, isolation of victims, and estrangement from family and community. Future research must investigate what role reporting (or the lack of it) plays in repeat victimization of scam victims.

Online fraud constantly evolves, with fraudsters inventing new subtle manipulation techniques. Although the current study involved six of the most common online fraud scenarios, victims' characteristics should be further tested for vulnerability to scams operating with new social engineering methods. The risk factors deriving from computer-related vocational activities and single parenthood of older age groups, and the possible protective roles of close proxy family members and caretakers must be further studied in light of the current findings.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: Longitudinal Survey of Cybercriminology: https://data.lib.vt.edu/articles/dataset/Longitudinal_Survey_of_Cybercriminology_November_2019/17092283.

Ethics statement

The studies involving human participants were reviewed and approved by Virginia Tech Institutional Review Board #19-1010. The patients/participants provided their written informed consent to participate in this study.

Author contributions

The author confirms being the sole contributor of this work and has approved it for publication.

Funding

The research was funded by the Institute for Society Culture and Environment at Virginia Tech, and the Niles Grant at the College of Arts and Liberal Sciences at Virginia Tech.

Conflict of interest

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

AARP (1996). Telemarketing fraud and older Americans: An AARP survey. Washington, DC: American Association of Retired Persons. Available at: https://www.ojp.gov/ncjrs/virtual-library/abstracts/telemarketing-fraud-and-older-americans-aarp-survey [Accessed December 29, 2021].

AARP (1999). Consumer behavior, experiences and attitudes: A comparison by age groups. Washington, DC: American Association of Retired Persons. Available at: http://assets.aarp.org/rgcenter/consume/d16907_behavior.pdf [Accessed December 29, 2021].

Anderson, K.B. (2004). Consumer fraud in the United States: An FTC survey. Staff Report of the Bureaus of Economics and Consumer Protection. Federal Trade Commission. Available at: https://www.ftc.gov/sites/default/files/documents/reports/consumer-fraud-united-states-ftc-survey/040805confraudrpt.pdf [Accessed December 29, 2021].

Anderson, K.B. (2007). Consumer fraud in the United States: The second FTC survey. Staff Report of the Bureaus of Economics and Consumer Protection. Federal Trade Commission. Available at: https://www.ftc.gov/sites/default/files/documents/reports/consumer-fraud-united-states-second-federal-trade-commission-survey-staff-report-federal-trade/fraud.pdf [Accessed December 29, 2021].

Anderson, K.B. (2013). Consumer fraud in the United States, 2011: The third FTC survey. Staff Report of the Bureaus of Economics and Consumer Protection. Federal Trade Commission. Available at: https://www.ftc.gov/sites/default/files/documents/reports/consumer-fraud-united-states-2011-third-ftc-survey/130419fraudsurvey_0.pdf [Accessed December 29, 2021].

Beals, M. E., Carr, D. C., Mottola, G. R., Deevy, M. J., and Carstensen, L. L. (2015a). How does survey context impact self-reported fraud victimization? *The Gerontologist* 57, 329–340. doi: 10.1093/geront/gnv082

Beals, M.E., DeLiema, M., and Deevy, M. (2015b). Framework for a taxonomy of fraud. Stanford Center on Longevity and FINRA Investor Education Foundation. Available at: http://longevity3.stanford.edu/framework-for-a-taxonomy-of-fraud/ [Accessed December 29, 2021].

Bewick, V., Cheek, L., and Ball, J. (2004). Statistics review 10: further nonparametric methods. *Crit. Care* 8, 196–199. doi: 10.1186/cc2857

Bossler, A. M., and Holt, T. (2009). On-line activities, guardianship, and malware infection: an examination of routine activities theory. *Int. J. Cyber Criminol.* 3, 400–420.

Boyle, P. A., Yu, L., Wilson, R. S., Gamble, K., Buchman, A. S., and Bennett, D. A. (2012). Poor decision making is a consequence of cognitive decline among older persons without Alzheimer's disease or mild cognitive impairment. *PLoS One* 7:e43647. doi: 10.1371/journal.pone.0043647

Burnes, D., Henderson, C. R., Sheppard, C., Zhao, R., Pillemer, K., and Lachs, M. S. (2017). Prevalence of financial fraud and scams among older adults in the United States: a systematic review and meta-analysis. *Am. J. Public Health* 107, e13–e21. doi: 10.2105/AJPH.2017.303821

Burnett, J., Jackson, S. L., Sinha, A. K., Aschenbrenner, A. R., Murphy, K. P., Xia, R., et al. (2016). Five-year all-cause mortality rates across five types of substantiated elder abuse occurring in the community. *J. Elder Abuse Negl.* 28, 59–75. doi: 10.1080/08946566.2016.1142920

Carcach, C., Graycar, A., and Muscat, G. (2001). The victimisation of older Australians. Trends and issues in crime and criminal justice, 212, 1–6. Canberra: Australian Institute of Criminology. Available at: https://www.aic.gov.au/publications/tandi/tandi212 [Accessed December 29, 2021].

Choi, K.-S. (2008). Computer crime victimization and integrated theory: an empirical assessment. *Int. J. Cyber Criminol.* 2, 308–333.

Choi, K.-S., and Lee, J. R. (2017). Theoretical analysis of cyber-interpersonal violence victimization and offending using cyber-routine activities theory. *Comput. Hum. Behav.* 73, 394–402. doi: 10.1016/j.chb.2017.03.061

Cohen, L. E., and Felson, M. (1979). Social change and crime rate trends: a routine activity approach. *Am. Sociol. Rev.* 44, 588–560. doi: 10.2307/2094589

Cross, C. (2016). "They're very lonely": understanding the fraud victimisation of seniors. *Int. J. Crime, Justice Soc. Democr.* 5, 60–75. doi: 10.5204/ijcjsd.v5i4.268

Cross, C. (2020a). "Responding to individual fraud: perspectives of the fraud justice network" in *The human factor of cybercrime*. eds. E. R. Leukfeldt and T. J. Holt (New York: Routledge Studies In Crime and Society), 359–388.

Cross, C. (2020b). "Romance fraud" in *Palgrave handbook of international cybercrime and Cyberdeviance*. eds. T. J. Holt and A. Bossler (Switzerland: Palgrave Macmillan), 1–22.

Deevy, M., and Beals, M. (2013). The scope of the problem: an overview of fraud prevalence measurement. Stanford University Financial Fraud Research Center. Available at: http://longevity3.stanford.edu/the-scopeof-the-problem-an-overview-of-fraud-prevalencemeasurement [Accessed December 30, 2021].

DeLiema, M. (2018). Elder fraud and financial exploitation: application of routine activity theory. *The Gerontologist* 58, 706–718. doi: 10.1093/geront/gnw258

Dolbin-MacNab, M. L. (2019). "Grandparenthood" in *APA handbook of contemporary family psychology: Foundations, methods, and contemporary issues across the lifespan*. eds. B. H. Fiese, M. Celano, K. Deater-Deckard, E. N. Jouriles and M. A. Whisman (Washington, DC: American Psychological Association), 557–574.

Dong, X., and Simon, M. A. (2013). Elder abuse as a risk factor for hospitalization in older persons. *JAMA Intern. Med.* 173, 911–917. doi: 10.1001/jamainternmed.2013.238

FBI (2020). Elder fraud. Federal Bureau of Investigation. FBI.gov. Available at: https://www.fbi.gov/scams-and-safety/common-scams-and-crimes/elder-fraud [Accessed December 30, 2021]

Federal Trade Commission (2003). Identity theft survey report. Federal Trade Commission. Available at: https://www.ftc.gov/sites/default/files/documents/reports/federaltrade-commission-identity-theft-program/synovatereport.pdf [Accessed December 30, 2021].

Felson, M. (1986). "Routine activities, social controls, rational decisions and criminal outcomes" in *The reasoning criminal*. eds. D. Cornish and R. Clarke (New York: Springer), 302–327.

Fenge, L.-A., and Lee, S. (2018). Understanding the risks of financial scams as part of elder abuse prevention. *Br. J. Soc. Work.* 48, 906–923. doi: 10.1093/bjsw/bcy037

FINRA (2016). Financial fraud in the United States. Nontraditional costs of financial fraud. Research report, FINRA investor education foundation. Available at: https://www.finrafoundation.org/files/non-traditional-costs-financial-fraud [Accessed December 30, 2021].

Gamble, K.J., Boyle, P., Yu, L., and Bennett, D. (2014). The causes and consequences of financial fraud among older Americans. Center for Retirement Research at Boston College, WP 2014-13. Available at: https://ssrn.com/abstract=2523428 [Accessed December 30, 2021]

Ganzini, L., McFarland, B. H., and Cutler, D. (1990). Prevalence of mental disorders after catastrophic financial loss. *J. Nerv. Ment. Dis.* 178, 680–685. doi: 10.1097/00005053-199011000-00002

Generations United (2014). The state of grandfamilies in America: 2014. Full report. Generations United. Available at: https://www.gu.org/resources/the-state-of-grandfamilies-in-america-2014/ [Accessed December 30, 2021].

González, A., Ramírez, M. P., and Viadel, V. (2015). ICT learning by older adults and their attitudes toward computer use. *Curr. Gerontol. Geriatr. Res.* 2015, 1–7. doi: 10.1155/2015/849308

Graycar, A., and James, M. (2001). Older people and consumer law. Paper presented at 4th National Outlook Symposium on crime in Australia: New crimes or new responses, Canberra 21–22 June 2001. Australian Institute of Criminology. Available at: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.580.6967&rep=rep1&type=pdf [Accessed December 30, 2021].

Hall, J.E., Karch, D.L., and Crosby, A.E. (2016). Elder abuse surveillance: Uniform definitions and recommended core data elements for use in elder abuse surveillance, version 1.0, Atlanta, GA: National Center for Injury Prevention and Control, Centers for Disease Control and Prevention. Available at: https://www.cdc.gov/violenceprevention/pdf/ea_book_revised_2016.pdf [Accessed December 30, 2021].

Harrell, E. (2015). Victims of identity theft, 2014. Revised 13 November 2017. US Department of Justice, Bureau of Justice Statistics. Available at: https://bjs.ojp.gov/content/pub/pdf/vit14.pdf [Accessed December 30, 2021].

Harrell, E., and Langton, L. (2013). Victims of identity theft, 2012. US Department of Justice, Bureau of Justice Statistics. Available at: http://www.bjs.gov/content/pub/pdf/vit12.pdf [Accessed December 30, 2021].

Hart, A. (2001). Mann-Whitney test is not just a test of medians: differences in spread can be important. *Br. Med. J. (Clin. Res. Ed.)* 323, 391–393. doi: 10.1136/bmj.323.7309.391

Hawdon, J., Parti, K., and Dearden, T. (2020). Cybercrime in America amid COVID. The initial results of a natural experiment. *Am. J. Crim. Justice* 45, 546–562. doi: 10.1007/s12103-020-09534-4

Hayslip, B., and Kaminski, P. L. (2005). Grandparents raising their grandchildren: a review of the literature and suggestions for practice. *The Gerontologist* 45, 262–269. doi: 10.1093/geront/45.2.262

Holtfreter, K., Reisig, M. D., and Blomberg, T. G. (2006). Consumer fraud victimization in Florida: an empirical study. *St Thomas Law Rev.* 18, 761–789.

Holtfreter, K., Reisig, M.D., Mears, D.P., and Wolfe, S.E. (2014). Financial exploitation of the elderly in a consumer context. research report Center for Victim Research. Available at: https://ncvc.dspacedirect.org/bitstream/id/2044/Financial%20Exploitation%20of%20the%20Elderly_IR_508.pdf [Accessed December 30, 2021].

Holtfreter, K., Reisig, M. D., and Pratt, T. C. (2008). Low self-control, routine activities, and fraud victimization. *Criminology* 46, 189–220. doi: 10.1111/j.1745-9125.2008.00101.x

Hutchings, A., and Heyes, H. (2009). Routine activity theory and phishing victimisation: who gets caught in the 'net'? *Curr. Issues Crim. Justice* 20, 433–452. doi: 10.1080/10345329.2009.12035821

IC3 (2020) Elder fraud report. Federal Bureau of Investigation, internet crime complaint center. Available at: https://www.ic3.gov/Media/PDF/AnnualReport/2020_IC3ElderFraudReport.pdf [Accessed December 30, 2021].

Kennedy, L. W., and Forde, D. R. (1990). Routine activities and crime: an analysis of victimization in Canada. *Criminology* 28, 137–152. doi: 10.1111/j.1745-9125.1990.tb01321.x

Kennedy, J. P., Rorie, M., and Benson, M. L. (2021). COVID-19 frauds: an exploratory study of victimisation during a global crisis. *Criminol. Public Policy* 20, 493–543. doi: 10.1111/1745-9133.12554

Kitchen, C. M. R. (2009). Nonparametric versus parametric tests of location in biomedical research. *Am J. Ophthalmol.* 147, 571–572. doi: 10.1016/j.ajo.2008.06.031

Kowalski, M. (2002). *Cyber-crime: Issues, data sources, and feasibility of collecting police-reported statistics*. Ottawa: Statistics Canada

Langenderfer, J., and Shimp, T. A. (2001). Consumer vulnerability to scams, swindles, and fraud: a new theory of visceral influences on persuasion. *Psychol. Mark.* 18, 763–783. doi: 10.1002/mar.1029

Lea, S.E.G., Fischer, P., and Evans, K.M. (2009). The psychology of scams: Provoking and committing errors of judgement, report for the office of fair trading. Available at: https://ore.exeter.ac.uk/repository/handle/10871/20958 [Accessed December 30, 2021].

Lee, J., and Geistfeld, L. (1999). Elderly consumers' receptiveness to telemarketing fraud. *J. Public Policy Mark.* 18, 208–217. doi: 10.1177/074391569901800207

Leukfeldt, E. R., and Yar, M. (2016). Applying routine activity theory to cybercrime: a theoretical and empirical analysis. *Deviant Behav.* 37, 263–280. doi: 10.1080/01639625.2015.1012409

Lichtenberg, P. A., Stickney, L., and Paulson, D. (2013). Is psychological vulnerability related to the experience of fraud in older adults? *Clin. Gerontol.* 36, 132–146. doi: 10.1080/07317115.2012.749323

Lichtenberg, P. A., Sugarman, M. A., Paulson, D., Ficker, L. J., and Rahman-Filipiak, A. (2016). Psychological and functional vulnerability predicts fraud cases in older adults: results of a longitudinal study. *Clin. Gerontol.* 39, 48–63. doi: 10.1080/07317115.2015.1101632

Lopes, R. H. C. (2011). "Kolmogorov-Smirnov Test" in *International encyclopedia of statistical science*. ed. M. Lovric (Berlin, Heidelberg: Springer) doi: 10.1007/978-3-642-04898-2_326

Massey, J., Krohn, M., and Bonati, L. (1989). Property crime and the routine activities of individuals. *J. Res. Crime Delinq.* 26, 378–400. doi: 10.1177/0022427889026004004

Matute, H., Blanco, F., Yarritu, I., Díaz-Lago, M., Vadillo, M. A., and Barberia, I. (2015). Illusions of causality: how they bias our everyday thinking and how they could be reduced. *Front. Psychol.* 6:888. doi: 10.3389/fpsyg.2015.00888

Miethe, T., Stafford, M., and Long, J. S. (1987). Social differentiation in criminal victimization: a test of routine activities/lifestyle theories. *Am. Sociol. Rev.* 52, 184–194.

Moitra, S. D. (2005). Developing policies for cyber crime. *Eur. J. Crime Crim. Law Crim. Justice* 13, 435–464. doi: 10.1163/1571817054604119

Molnar, A. (1997). Computers in education: a brief history. THE Journal. Available at: https://thejournal.com/Articles/1997/06/01/Computers-in-Education-A-Brief-History.aspx?m=1&Page=1 [Accessed December 30, 2021].

Nachar, N. (2008). The Mann-Whitney U: a test for assessing whether two independent samples come from the same distribution. *Tutor. Quant. Methods Psychol.* 4, 13–20. doi: 10.20982/tqmp.04.1.p013

Nahm, F. S. (2016). Non-parametric statistical tests for the continuous data: the basic concept and the practical use. *Korean J. Anesthesiol.* 69, 8–14. doi: 10.4097/kjae.2016.69.1.8

Newman, G.R., and Clarke, R.V.G. (2003). *Superhighway robbery: Preventing e-commerce crime*. United Kingdom: Willan

Ostertagova, E., Ostertagova, O., and Kováč, J. (2014). Methodology and application of the Kruskal-Wallis test. *Appl. Mech. Mater.* 611, 115–120. doi: 10.4028/www.scientific.net/AMM.611.115

Pak, K., and Shadel, D. (2011). AARP Foundation national fraud victim study. Washington, DC: AARP. Available at: https://assets.aarp.org/rgcenter/general/fraud-victims-11.pdf [Accessed December 30, 2021].

Parker, K., and Davey, B. (2014). "Computers in schools in the USA: a social history" in *Reflections on the history of computers in education: Early use of computers and teaching about computing in schools, AICT-424*. eds. A. Tatnall and B. Davey (Switzerland: Springer), 203–211.

Pratt, T. C., Holtfreter, K., and Reisig, M. (2010). Routine online activity and internet fraud targeting: extending the generality of routine activity theory. *J. Res. Crime Delinq.* 47, 267–296. doi: 10.1177/0022427810365903

Prensky, M. (2001). Digital natives, digital immigrants. *Horizon* 9, 1–6. doi: 10.1108/10748120110424816

Reisig, M. D., and Holtfreter, K. (2013). Shopping fraud victimization among the elderly. *J. Financ. Crime* 20, 324–337. doi: 10.1108/JFC-03-2013-0014

Reyns, B. W. (2015). A routine activity perspective on online victimization: results of the Canadian general social survey. *J. Financ. Crime* 22, 396–411. doi: 10.1108/JFC-06-2014-0030

Roncek, D. W., and Maier, P. A. (1991). Bars, blocks, and crimes revisited: linking the theory of routine activities to the empiricism of hot spots. *Criminology* 29, 725–753. doi: 10.1111/j.1745-9125.1991.tb01086.x

Saxena, D., and Brotherson, S. (2021). When grandparents become parents to their grandchildren. The art of Grandparenting no. 11. North Dakota State University. Available at: https://www.ag.ndsu.edu/publications/home-farm/when-grandparents-become-parents-to-their-grandchildren [Accessed December 30, 2021].

Sherman, L. W., Gartin, P. R., and Buerger, M. E. (1989). Hot spots of predatory crime: routine activities and the criminology of place. *Criminology* 27, 27–56. doi: 10.1111/j.1745-9125.1989.tb00862.x

Simons, J.J., Phillips, N.J., Chopra, R., Slaughter, R.K., and Wilson, C.S. (2020). Protecting older consumers 2019–2020. Report of the Federal Trade Commission to congress, 18 October, 2020. Available at: https://www.ftc.gov/system/files/documents/reports/protecting-older-consumers-2019-2020-report-federal-trade-commission/p144400_protecting_older_adults_report_2020.pdf [Accessed December 30, 2021].

Smith, R. G., and Budd, C. (2009). Consumer fraud in Australia: costs, rates and awareness of the risks. *Trends Issues Crime Crim. Justice* 382, 1–6.

Tai, K. Y., Dhaliwal, J., and Balasubramaniam, V. (2022). Leveraging Mann-Whitney U test on large-scale genetic variation data for analysing malaria genetic markers. *Malar. J.* 21:79. doi: 10.1186/s12936-022-04104-x

Temple, J. (2007). Older people and credit card fraud. *Trends Issues Crime Crim. Justice* 343, 1–6.

Thompson, S. C. (1999). Illusions of control: how we overestimate our personal influence. *Curr. Dir. Psychol. Sci.* 8, 187–190. doi: 10.1111/1467-8721.00044

Titus, R., Heinzelmann, F., and Boyle, J. (1995). Victimisation of persons by fraud. *Crime Delinq.* 41, 54–72.

Whitty, M. T. (2019). Predicting susceptibility to cyber-fraud victimhood. *J. Financ. Crime* 26, 277–292. doi: 10.1108/JFC-10-2017-0095

Yar, M. (2005). The novelty of 'cybercrime': an assessment in light of routine activity theory. *Eur. J. Criminol.* 2, 407–427.

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 21 June 2023
DOI 10.3389/fpsyg.2023.1195463

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OPEN ACCESS

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RECEIVED 28 March 2023
ACCEPTED 06 June 2023
PUBLISHED 21 June 2023

CITATION
Ikenouchi A, Okamoto N, Matsumoto T and Yoshimura R (2023) Effect of the personality traits of healthy Japanese workers on depressive symptoms and social adaptation, and on the achievement rate of exercise therapy to prevent major depression. *Front. Psychol.* 14:1195463. doi: 10.3389/fpsyg.2023.1195463

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Effect of the personality traits of healthy Japanese workers on depressive symptoms and social adaptation, and on the achievement rate of exercise therapy to prevent major depression

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Background: This study determined the effects of personality traits on depressive symptoms and social adaptation in healthy workers, and the effects of depressive symptoms or social adaptation before and after exercise therapy, and personality traits before exercise therapy on the achievement rates of exercise therapy aimed at preventing major depression.

Methods: Two hundred fifty healthy Japanese workers were given an eight-week walking program as exercise therapy. After excluding 35 participants who had dropped or provided incomplete information, 215 were included in the analysis. The Japanese version of the NEO five-factor inventory was used to assess participants' personality traits before the exercise therapy. Depressive symptoms were evaluated using the Japanese version of the Zung self-rating depression scale (SDS-J) and social adaptation was evaluated using the Japanese version of the social adaptation self-evaluation scale (SASS-J) before and after the exercise therapy.

Results: The SDS-J scores correlated with neuroticism and negatively correlated with extraversion, agreeableness, and conscientiousness before the exercise therapy. The SDS-J was also negatively correlated with openness in women, but not in men, while the SASS-J was associated with extraversion, openness, agreeableness, and conscientiousness, and negatively correlated with neuroticism. There was no significant change in levels of depression before and after exercise therapy; however, social adaptation increased significantly in men. No association was found between SDS-J and SASS-J scores before the exercise therapy and the achievement rate. The achievement rates of exercise therapy were negatively correlated with SDS-J or SASS-J after exercise therapy in women. The SDS-J after exercise therapy was correlated with neuroticism in men and negatively correlated with extraversion in women. The SASS-J after exercise therapy was negatively correlated with neuroticism and correlated with extraversion and openness in men. In contrast, the SASS-J after exercise therapy correlated with openness and agreeableness in women. Conscientiousness was

correlated with the achievement rate of exercise therapy in men, but not with the various personality traits in women.

Conclusion: Depressive symptoms and social adaptation were differently associated with personality traits and achievement rates before and after exercise therapy. Conscientiousness before exercise therapy predicted a higher achievement rate for exercise therapy in men.

KEYWORDS

exercise therapy, personality traits, NEO-FFI, healthy worker, prevention of major depression

1. Introduction

Depression is a common psychiatric disorder. Approximately 280 million people worldwide suffer from depression and it affects an estimated 3.8% of the global population (World Health Organization, 2021). Depression is the leading cause of disability worldwide, and accounts for 40.5% of disability-adjusted life years due to psychiatric and substance use disorders (Whiteford et al., 2013). Personality traits also affect physical and mental health (Strickhouser et al., 2017). The etiology of depression is multifactorial, but personality traits are considered one of the most important predictors of depression.

Personality traits are characterized by persistent patterns of thinking, feeling, and behavior that are formed throughout childhood and become increasingly consistent throughout life (Corr and Matthews, 2009). One of the most common conceptualizations of personality is the five-factor personality model, which includes five dimensions of personality traits, including neuroticism, extraversion, openness, agreeableness, and conscientiousness as essential characteristics of personality (McCrae and Costa, 1987). Personality traits may also be influenced by age, gender, and race; for example, neuroticism is known to be higher among women in the American population, but not among Japanese or Black South Africans (Hyde, 2014; Hakulinen et al., 2015; Serrano et al., 2022).

Various studies have investigated the association between personality traits and depression. People with depressive disorders, including major depressive disorder, unipolar depression, and dysthymic disorder, have higher levels of neuroticism and lower levels of extraversion and conscientiousness than healthy controls (Kotov et al., 2010). In a large meta-analysis involving 117,899 participants, low extraversion, high neuroticism, and low conscientiousness were associated with depressive symptoms in cross-sectional analyses. Similar associations were associated with an increased risk of depressive symptoms during follow-ups in longitudinal studies adjusted for baseline depressive symptoms (Hakulinen et al., 2015).

Physical inactivity also increases the risk of depression (Lampinen et al., 2000). A longitudinal retrospective study has suggested that physically active students have a lower incidence of depression (Paffenbarger et al., 1994). Several narrative reviews have concluded that physical activity can prevent depression (Teychenne et al., 2008; Mammen and Faulkner, 2013). We previously reported that an exercise intervention using walking significantly reduced depressive symptoms and improved social adaptation in workers with no exercise habits (Ikenouchi-Sugita et al., 2013). One meta-analysis reported that extraversion and conscientiousness are positively correlated with physical activity, while neuroticism is inversely associated with physical activity (Rhodes and Smith, 2006). Although studies have shown an association between personality traits and depression or physical activity, it is unclear which personality traits are more likely to be associated with adherence and high achievement rates in exercise therapy to prevent major depression. Exercise therapy requires active engagement; therefore, levels of depressive symptoms, social adaptation and personality traits may affect adherence or achievement rates.

The purpose of this study is to determine the effects of personality traits before exercise therapy on depressive symptoms or social adaptation before and after exercise therapy in healthy Japanese workers and to determine the effects of depressive symptoms or social adaptation before and after exercise therapy, and personality traits before exercise therapy on the achievement rate of exercise therapy for the prevention of major depression.

2. Materials and methods

2.1. Participants and procedures

Participants were recruited among workers at the University of Occupational and Environmental Health, Japan and its affiliated facilities via notice boards at the facilities. The study was explained to 1,529 people, and 257 gave their written consent to participate in the study. Of these, 227 were healthcare workers and 30 were physical laborers. The participants were asked on paper whether they had a history of mental illness. After excluding seven participants with a history of mental illness, 250 participants were assessed for depressive symptoms, social adaptation, and personality traits. Eight weeks of walking were administered as exercise therapy. Thirty-five participants dropped out during the study or gave incomplete information were excluded. The remaining 215 who completed the study were included in the analysis.

The Japanese version of the NEO five-factor inventory (NEO-FFI) was administered as a baseline to assess personality traits before the start of the exercise therapy. The Japanese versions of the Zung self-rating depression scale (SDS-J) (Zung et al., 1965) and social adaptation self-evaluation scale (SASS-J) (Ueda et al., 2011) were used to evaluate participants' depressive symptoms and social adaptation before and 8 weeks after the start of the exercise therapy.

We analyzed the relationship between the SDS-J or SASS-J before and after exercise therapy and each of the NEO-FFI before exercise

therapy; changes in SDS-J and SASS-J before and after exercise therapy; and the relationship between the achievement rate of exercise therapy and the SDS-J or SASS-J before and after exercise therapy and each item of the NEO-FFI before exercise therapy.

2.2. Exercise therapy

All the participants received instructions on paper to walk the equivalent of 17.5 kcal/kg/week, spread over at least 3 days per week. This amount of activity is the recommended public health dose and considered effective for mild to moderate depression (Dunn et al., 2005). For example, a participant weighing 60 kg needs to exercise an equivalent of 1,050 kcal per week; if it takes approximately 34 steps to burn 1 kcal, the participant needs to walk 35,700 steps per week. If the participant walks 5 days a week, the goal is 7,140 steps per day. To assess adherence to the specified exercise regimen, participants were instructed to wear a pedometer that displays the number of steps taken and calories burned. The achievement rate (%) was calculated by dividing the number of steps walked by the target number of steps for the 8 weeks and multiplying the results by 100.

2.3. Assessment of personality traits

Personality traits were assessed using the Japanese version of the NEO-FFI, which comprises five dimensions: neuroticism, extraversion, openness, agreeableness, and conscientiousness. The Cronbach's alpha coefficients were 0.83 for neuroticism, 0.78 for extraversion, 0.75 for openness, 0.68 for agreeableness, and 0.77 for conscientiousness, which confirmed the reliability of the Japanese version of the NEO-FFI (Shiranaka et al., 2011).

2.4. Assessment of the level of depressive state

The level of depressive symptoms was assessed using the SDS-J, a self-administered 20-item scale. The means (standard deviation) of the raw scores were 35 (12) for normal, 49 (10) for neurosis, and 60 (7) for depression, with SDS-J values increasing in proportion to the depressive state (Zung et al., 1965; Fukuda and Kobayashi, 2011).

2.5. Assessment of the level of social adaptation

The level of social adaptation was assessed using the SASS-J, which is a self-administered measure of social adaptation. The higher the SASS-J score, the higher the level of social adaptation. The cutoff value for predicting social adaptation in depressed patients is 25/26. The Cronbach's alpha coefficient of the SASS-J was 0.81, which confirmed its reliability (Ueda et al., 2011).

2.6. Statistical analysis

All the statistical analyses were performed using Stata/SE 17.0. Continuous variable data are presented as means (standard deviation) and nominal variable data as percentages. A univariate analysis of the differences in each item was performed using a paired *t*-test. Statistical data were expressed as standard errors. Univariate correlations for each item were evaluated using Spearman's rank sum test, and multivariate analyses adjusted for covariates were performed using multiple regression analysis. The test was two-tailed, with a p-value < 0.05 considered statistically significant.

3. Ethics statement

The study was conducted in accordance with the 1975 Declaration of Helsinki (revised in 2008). All the procedures involving human subjects were approved by the Ethics Committee of the University of Occupational and Environmental Health, Japan (Approval No. 10-076), and written informed consent was obtained from all participants.

4. Results

Table 1 summarizes participants' demographic information. Of the 215 participants, 70 were men, 145 were women, and 197 adhered to the exercise regimen, while 18 did not. The achievement rate of the exercise therapy was 142% for men and 200% for women, which was well above the target number of steps. Table 2 shows the association between personality traits and SDS-J scores at baseline. The SDS-J scores correlated positively with neuroticism and negatively with extraversion, agreeableness, and conscientiousness in men and women. SDS-J and openness showed no association in men but were negatively correlated in women. These trends were similar in both univariate and multivariate analyses. Table 3 shows the associations between personality traits and SASS-J at baseline. The SASS-J was negatively correlated with neuroticism, and positively correlated with extraversion, openness, agreeableness, and conscientiousness in men

TABLE 1 Participant demographics.

	All	Men	Women
Participants (*n*)	215	70	145
Age	41.7 (12.4)	41.8 (11.8)	41.7 (12.6)
Exercise habits	63 (29%)	26 (37%)	37 (26%)
Personality traits			
Neuroticism	24.7 (7.54)	24.1 (7.96)	25.0 (7.34)
Extraversion	25.1 (6.15)	24.6 (6.57)	25.3 (5.94)
Openness	28.5 (5.37)	27.8 (6.26)	28.9 (4.87)
Agreeableness	31.5 (4.67)	30.8 (4.41)	31.9 (4.76)
Conscientiousness	27.2 (5.68)	26.2 (5.88)	27.7 (5.53)
Adherence	197 (92%)	54 (77%)	143 (99%)
Achievement rate (%)	181 (7.56)	142 (7.15)	200 (6.25)

The continuous variable data are shown as means (standard deviation).

10.3389/fpsyg.2023.1195463

TABLE 2 Relationship between baseline SDS-J and personality traits.

	Univariable		Multivariable			
NEO-FFI	Spearman's rank correlation coefficient (r)	p-value	Standard partial regression coefficient (β)	Standard error	t-value	Adjusted p-value
Neuroticism						
All participants	0.514	<0.001*	0.586	0.063	10.18	<0.001*
Men	0.506	<0.001*	0.533	0.105	5.14	<0.001*
Women	0.503	<0.001*	0.625	0.079	8.84	<0.001*
Extraversion						
All participants	−0.379	<0.001*	−0.420	0.085	−6.63	<0.001*
Men	−0.461	<0.001*	−0.482	0.137	−4.31	<0.001*
Women	−0.356	<0.001*	−0.390	0.108	−5.00	<0.001*
Openness						
All participants	−0.217	0.0014*	−0.222	0.104	−3.27	0.001*
Men	−0.226	0.0595	−0.243	0.165	−1.90	0.062
Women	−0.238	0.004*	−0.212	0.139	−2.58	0.011*
Agreeableness						
All participants	−0.283	<0.001*	−0.392	0.112	−6.17	<0.001*
Men	−0.305	0.0103*	−0.326	0.213	−2.79	0.007*
Women	−0.321	<0.001*	−0.423	0.135	−5.45	<0.001*
Conscientiousness						
All participants	−0.254	<0.001*	−0.271	0.097	−4.06	<0.001*
Men	−0.316	0.0076*	−0.299	0.162	−2.54	0.014*
Women	−0.230	0.0055*	−0.256	0.121	−3.15	0.002*

In the multivariate analysis, the SDS-J was the objective variable, age and exercise habits were covariates, and personality traits were explanatory variables. Sex was also included as a covariate for all participants. *Statistical significance was set at $p < 0.05$.

and women. These trends were similar in both univariate and multivariate analyses. Table 4 shows the changes in SDS-J and SASS-J scores before and after exercise intervention. The SDS-J scores were within the normal range for both men and women, with no significant change before or after exercise therapy. The SASS-J scores were also within the normal range for both men and women, with a significant increase in SASS-J scores after exercise therapy in men, but no significant change in women. Table 5 shows the associations between the baseline SDS-J and SASS-J scores and exercise therapy attainment. No groups showed any association with baseline SDS-J or SASS-J. These trends were similar in both univariate and multivariate analyses. Table 6 shows the associations between the scores of SDS-J or SASS-J at 8 weeks and the achievement rate of exercise therapy. In univariate analysis, no association was found between the achievement rate of exercise therapy and the SDS-J or SASS-J after exercise therapy. Multivariate analysis showed negative associations between the achievement rate of exercise therapy and the SDS-J or SASS-J after exercise therapy in women. Table 7 shows the association between personality traits at baseline and SDS-J at 8 weeks. In univariate analysis, the SDS-J correlated with neuroticism after exercise therapy, while extraversion, openness, and conscientiousness correlated negatively for men and women. The SDS-J after exercise therapy was negatively correlated with agreeableness in women. In multivariate analysis, SDS-J after exercise therapy correlated with neuroticism in men and negatively correlated with extraversion in women. Table 8 shows the association between baseline personality traits and SASS-J scores at 8 weeks. In univariate analyses, the SASS-J after exercise therapy was negatively correlated with neuroticism and positively correlated with extraversion, openness, agreeableness, and conscientiousness for men and women. In multivariate analysis, the SASS-J after exercise therapy showed a similar trend as in univariate analysis for all participants. The SASS-J after exercise therapy was negatively correlated with neuroticism and positively correlated with extraversion and openness in men. The SASS-J after exercise therapy was positively correlated with openness and agreeableness in women. Table 9 shows the association between the achievement rate of the exercise therapy and personality traits. Univariate analysis showed an association between achievement rate and conscientiousness for all groups. The association between achievement rate and extraversion was found only in men. Multivariate analysis showed a positive association between achievement rate and conscientiousness for men.

5. Discussion

This is the first study to clarify the relationship between depressive symptoms, social adaptation, and personality traits in healthy Japanese workers and their impact on the achievement rate of exercise therapy to prevent major depression. This study reveals personality traits in men and women that could make exercise therapy more effective in

TABLE 3 Relationship between baseline SASS-J and personality traits.

	Univariable		Multivariable			
NEO-FFI	Spearman's rank correlation coefficient (r)	p-value	standard partial regression coefficient (β)	standard error	t-value	adjusted p-value
Neuroticism						
All participants	−0.391	<0.001*	−0.462	0.050	−7.39	<0.001*
Men	−0.428	<0.001*	−0.443	0.089	−4.16	<0.001*
Women	−0.374	<0.001*	−0.473	0.062	−6.05	<0.001*
Extraversion						
All participants	0.500	<0.001*	0.556	0.057	9.61	<0.001*
Men	0.533	<0.001*	0.584	0.101	5.81	<0.001*
Women	0.488	<0.001*	0.532	0.070	7.47	<0.001*
Openness						
All participants	0.373	<0.001*	0.390	0.073	6.09	<0.001*
Men	0.465	<0.001*	0.477	0.120	4.18	<0.001*
Women	0.330	<0.001*	0.349	0.094	4.46	<0.001*
Agreeableness						
All participants	0.343	<0.001*	0.387	0.083	6.09	<0.001*
Men	0.398	<0.001*	0.465	0.158	4.39	<0.001*
Women	0.322	<0.001*	0.346	0.098	4.33	<0.001*
Conscientiousness						
All participants	0.319	<0.001*	0.371	0.069	5.78	<0.001*
Men	0.486	<0.001*	0.475	0.119	4.51	<0.001*
Women	0.239	<0.001*	0.304	0.084	3.81	<0.001*

In the multivariate analysis, the SASS-J was the objective variable, age and exercise habits were covariates, and personality traits were explanatory variables. Sex was also included as a covariate for all participants. *Statistical significance was set at $p < 0.05$.

TABLE 4 Changes in SDS-J and SASS-J scores before and after exercise intervention.

	Baseline	8 weeks	p-value
SDS-J			
All participants	37.6 (8.21)	37.0 (6.79)	0.35
Men	36.5 (8.06)	35.6 (8.17)	0.21
Women	38.2 (8.25)	38.1 (8.34)	0.77
SASS-J			
All participants	36.8 (6.09)	37.0 (6.79)	0.37
Men	36.6 (6.61)	37.8 (6.80)	0.019*
Women	36.8 (5.85)	36.7 (6.79)	0.73

Paired t-tests were used to evaluate the results. *Statistical significance was set at $p < 0.05$.

mentally healthy workers, which will be useful when implementing exercise therapy to prevent major depression in the workplace.

In the present study, both depressive symptoms and social adaptation were within normal limits at baseline. Depressive symptoms were significantly correlated with neuroticism, whereas were negatively correlated with extraversion, agreeableness, and conscientiousness. Depressive symptoms were also negatively correlated with openness only in women.

Previous studies have shown that neuroticism is a predictor of stress, anxiety, and depression, while other factors are protective (Alizadeh et al., 2018). Another report showed that neuroticism is positively correlated with depressive symptoms, whereas extraversion, openness, agreeableness, and conscientiousness are negatively correlated with depressive symptoms (Gong et al., 2020), which is similar to the pre-exercise therapy results of the present study. Data on adults 18 years and older from the 2018 China Family Panel Study showed that conscientiousness, extraversion, and agreeableness are negatively associated with depressive symptoms, whereas openness and neuroticism are positively associated with depressive symptoms (Zhao et al., 2022). In the present study, openness was negatively correlated only in women. Studies have also reported that the negative association between conscientiousness and depressive symptoms is stronger in men than in women, and that the negative association between conscientiousness and agreeableness and depressive symptoms is strongest in older adults, followed by people in the middle-aged group, and then younger groups (Zhao et al., 2022). A prospective cohort study of community residents in Spain aged 35 years and older showed that neuroticism is associated with frequency estimates of subthreshold depressive symptoms; in women, openness is associated with the prevalence of subthreshold depressive symptoms; and in men, high extraversion is a protective factor in the development of subthreshold depressive symptoms. Neuroticism is

TABLE 5 Relationship between achievement rate and SDS-J and SASS-J scores at baseline.

	Univariable		Multivariable			
	Spearman's rank correlation coefficient (r)	p-value	Standard partial regression coefficient (β)	Standard error	t-value	Adjusted p-value
SDS-J						
All participants	0.016	0.82	−0.001	0.588	−0.02	0.99
Men	−0.023	0.85	−0.039	0.885	−0.33	0.74
Women	−0.027	0.75	0.007	0.760	0.09	0.93
SASS-J						
All participants	0.026	0.70	0.055	0.793	0.87	0.39
Men	−0.010	0.94	0.013	1.107	0.11	0.91
Women	0.058	0.49	0.087	1.073	1.03	0.31

In the multivariate analysis, the achievement rate was the objective variable, and age, and exercise habits were covariates. SDS-J or SASS-J scores at baseline were explanatory variables. Sex was also included as a covariate for all participants.

TABLE 6 Relationship between achievement rate and SDS-J and SASS-J scores at 8weeks.

	Univariable		Multivariable			
	Spearman's rank correlation coefficient (r)	p-value	Standard partial regression coefficient (β)	Standard error	t-value	Adjusted p-value
SDS-J						
All participants	−0.010	0.88	−0.174	0.856	−1.85	0.066
Men	−0.052	0.67	0.105	1.373	0.56	0.58
Women	−0.104	0.21	−0.274	1.077	−2.29	0.023*
SASS-J						
All participants	−0.009	0.89	−0.208	1.072	−2.16	0.032*
Men	0.102	0.40	0.010	1.974	0.04	0.97
Women	−0.016	0.85	−0.259	1.311	−2.19	0.030*

In the multivariate analysis, the achievement rate was the objective variable, and age, exercise habits, and SDS-J or SASS-J scores at baseline were covariates. SDS-J or SASS-J scores at 8 weeks were explanatory variables. Sex was also included as a covariate for all participants. *Statistical significance was set at $p < 0.05$.

associated with the prevalence of major depressive episodes in both men and women, and high conscientiousness is a protective factor (Serrano et al., 2022). The results of this study of healthy Japanese workers partially differ from earlier studies on personality traits other than neuroticism, which may have been caused by differences in sex, race, age, and country-specific cultural differences.

The present study's results show that the level of social adaptation before exercise therapy was negatively correlated with neuroticism, whereas extraversion, openness, agreeableness, and conscientiousness were correlated with social adaptation in both men and women. Previous studies have reported that social and academic adaptation are positively correlated with extraversion and conscientiousness and negatively correlated with neuroticism and depression, mostly consistent with the present study's results (Klimstra et al., 2018).

In this study, 92% of participants were able to adhere to the exercise therapy, and there was no change in the level of depressive symptoms in either men or women before and after exercise therapy, with a significant improvement in social adaptation in men. The UK government guidelines for adults recommend at least 150 min of moderate-intensity activity per week (Department of Health and Social Care, 2019). According to the Health Survey for England 2016, which included a specific chapter on physical activity, only 66% of men and 58% of women achieved this level (Scholes, 2017). Although strict comparisons could not be made because of the different activity settings, adherence and achievement rates were considered high for this study. We have previously reported that exercise intervention is useful in preventing depression and improving social adaptation in the workplace (Ikenouchi-Sugita et al., 2013). The results of the present study suggest that exercise therapy significantly affects social adaptation in men.

In healthy Japanese workers, the levels of depressive symptoms and social adaptation at baseline had no effect on achievement rates. Studies examining exercise therapy and adherence in patients with major depression have shown that the higher the level of depression, the lower the adherence to exercise (Kruisdijk et al., 2020). This result of the present study may be attributed to the fact that the participants were healthy workers without mental illness. If the subjects had depression or other psychiatric disorders, the depression levels might have affected the achievement rate.

No association between achievement rates and depressive symptoms or social adaptation after exercise therapy was found in the univariate analysis. However, in the multivariate analysis, a

TABLE 7 Relationship between SDS-J at 8 weeks and personality traits.

	Univariable		Multivariable			
NEO-FFI	Spearman's rank correlation coefficient (r)	p-value	Standard partial regression coefficient (β)	Standard error	t-value	Adjusted p-value
Neuroticism						
All participants	0.514	<0.001*	0.189	0.062	3.35	0.001*
Men	0.548	<0.001*	0.285	0.089	3.29	0.002*
Women	0.466	<0.001*	0.144	0.085	1.92	0.057
Extraversion						
All participants	−0.370	<0.001*	−0.129	0.069	−2.53	0.012*
Men	−0.468	<0.001*	−0.117	0.113	−1.28	0.21
Women	−0.348	<0.001*	−0.131	0.087	−2.11	0.037*
Openness						
All participants	−0.217	0.0014*	−0.083	0.074	−1.75	0.082
Men	−0.325	0.0060*	−0.156	0.111	−1.84	0.071
Women	−0.215	0.0096*	−0.061	0.101	−1.04	0.30
Agreeableness						
All participants	−0.220	0.0012*	0.008	0.091	0.16	0.88
Men	−0.151	0.21	0.053	0.155	0.63	0.53
Women	−0.313	<0.001*	−0.018	0.114	−0.28	0.78
Conscientiousness						
All participants	−0.215	0.0014*	−0.027	0.071	−0.56	0.58
Men	−0.330	0.0052*	−0.099	0.115	−1.20	0.23
Women	0.191	0.021*	0.011	0.091	0.18	0.86

In the multivariate analysis, the SDS-J at 8 weeks was the objective variable, and age, exercise habits, and SDS-J at baseline were covariates. Personality traits were explanatory variables. Sex was also included as a covariate for all participants. *Statistical significance was set at $p < 0.05$.

negative correlation was found between achievement rates and depressive symptoms or social adaptation after exercise therapy in women. The associations between depressive symptoms or social adaptation and personality traits after exercise therapy were almost similar to the results before exercise therapy in the univariate analysis. In multivariate analysis, the association between depressive symptoms and personality traits after exercise therapy was no longer correlated with neuroticism in women, no longer negatively correlated with extraversion in men, and no longer correlated with openness, agreeableness, or conscientiousness in either sex. After exercise therapy, social adaptation was not associated with neuroticism, extraversion, or conscientiousness in women, and with agreeableness and conscientiousness in men. Baseline depressive state and social adaptation as covariates may have influenced the results.

A correlation between conscientiousness and achievement rate was observed in men but not in women. No other personality traits were associated with achievement rates. The results of the present study show that conscientiousness predicts higher achievement rates in exercise therapy to prevent major depression in men. Individuals with high levels conscientiousness are more effective in developing the incremental behaviors necessary to achieve their goals (Stock and Beste, 2015). Individuals with high conscientiousness are purposeful and have a strong will (Shiranaka et al., 2011). High conscientiousness is also associated with more effective coping strategies that prevent negative life events and stressful experiences and reduce the risk of depression (Weiss et al., 2009). There is an interaction between sex and conscientiousness in the incidence of subthreshold depression, with men reporting a greater protective effect of this personality trait (Serrano et al., 2022). These studies explain the current study's finding of an association between exercise therapy achievement rates and conscientiousness. In healthy male workers, higher conscientiousness may predict higher achievement rates of exercise therapy and its effects.

Several studies have been published on exercise and personality traits. In a prospective study conducted in Australia, conscientiousness and openness predicted an increase in physical activity, whereas agreeableness was associated with a subsequent decrease in physical activity (Allen et al., 2017a). A study of older adults showed that extraversion, agreeableness, and conscientiousness are positively related to objectively measured physical activity, whereas neuroticism is negatively associated (Artese et al., 2017). A study of female college students also reported a negative relationship between neuroticism and physical activity (Wilson et al., 2015). A meta-analysis has suggested that the main personality traits associated with sedentary behavior are neuroticism (positively associated) and conscientiousness (negatively associated) (Allen et al., 2017b). The association between moderate physical activity and neuroticism, openness, and conscientiousness is known to vary from country to country (Gacek et al., 2021).

TABLE 8 Relationship between SASS-J at 8 weeks and personality traits.

	Univariable		Multivariable			
NEO-FFI	Spearman's rank correlation coefficient (r)	p-value	Standard partial regression coefficient (β)	Standard error	t-value	Adjusted p-value
Neuroticism						
All participants	−0.403	<0.001*	−0.133	0.046	−2.61	0.010*
Men	−0.468	<0.001*	−0.185	0.061	−2.61	0.011*
Women	−0.366	<0.001*	−0.099	0.063	−1.45	0.15
Extraversion						
All participants	0.559	<0.001*	0.136	0.060	2.50	0.013*
Men	0.684	<0.001*	0.305	0.078	4.06	<0.001*
Women	0.509	<0.001*	0.057	0.079	0.82	0.41
Openness						
All participants	0.423	<0.001*	0.161	0.061	3.33	0.001*
Men	0.478	<0.001*	0.166	0.084	2.14	0.036*
Women	0.407	<0.001*	0.156	0.085	2.56	0.011*
Agreeableness						
All participants	0.345	<0.001*	0.111	0.071	2.28	0.024*
Men	0.354	0.0027*	0.031	0.116	0.41	0.68
Women	0.374	<0.001*	0.132	0.089	2.13	0.035*
Conscientiousness						
All participants	0.337	<0.001*	0.109	0.058	2.25	0.025*
Men	0.492	<0.001*	0.129	0.086	1.72	0.089
Women	0.288	<0.001*	0.108	0.075	1.78	0.078

In the multivariate analysis, the SASS-J at 8 weeks was the objective variable, and age, exercise habits, and SASS-J at baseline were covariates. Personality traits were explanatory variables. Sex was also included as a covariate for all participants. *Statistical significance was set at $p < 0.05$.

The results of the current and previous studies on exercise and personality traits have been inconsistent. These differences may be due to differences in race, sex, cultural background, social position of the workers, and the types and methods of physical activity. This study was conducted using self-administered exercise therapy through paper-based instruction; the results may differ if face-to-face exercise instructions were provided.

Considering the above, one should be cautious in interpreting the present results. One interpretation is depressive symptoms or its associated factors and achievement of exercise therapy may be bidirectional. Depressive state, personality traits, or social adaptation associated with depressive state may influence the achievement of exercise therapy; conversely, exercise therapy may result in behavioral changes in depressive state via depressive state associated personality traits, or social adaptation.

Our study has several limitations. First, because participants volunteered, selection bias could be an issue if nonparticipation is associated with personality traits, various physical activities, or depressive symptoms. Second, adherence rates were high in this exercise therapy setting; therefore, it was impossible to determine the association between adherence and personality traits. Future studies should examine settings in which adherence to exercise therapy can withstand statistical analysis. Third, the presence of a history of mental illness was self-reported on paper. For a more rigorous study, the use of rating scales such as the K6, GHQ-12, and CES-D is preferred. Fourth, personality traits, depressive symptoms, and social adaptation were assessed using self-administered rating scales. Future studies should consider including clinicians to provide more reliable assessments. Fifth, the number of steps was measured using a pedometer that displayed the number of steps and calories burned, but was recorded by filling out a recording form. Future studies using physical activity monitors with accelerometers and long-term recording capabilities are required to evaluate the amount of physical activity. Sixth, although the participants' exercise habits were confirmed before the start of exercise therapy, the amount of exercise needed to be ascertained, and the possibility of these influences cannot be ruled out. Further studies are required to confirm these findings. Seventh, because the participants were employees of specific worksites and their affiliated worksites in Japan, caution should be exercised when generalizing the present results to workers with different backgrounds. These results should be confirmed in other occupations, industrial areas, and regions. Eighth, preliminary power tests were not conducted. However, these results are considered reliable and statistically significant. Last, we cannot rule out the possibility that other imperceptible confounding factors may have influenced the results. Therefore, further research is needed to confirm and develop these results.

6. Conclusion

In this study of healthy Japanese workers, depressive symptoms and social adaptation were differently associated with personality traits and achievement rates before and after exercise therapy.

TABLE 9 Relationship between achievement rates and personality traits.

	Univariable		Multivariable			
NEO-FFI	Spearman's rank correlation coefficient (r)	p-value	Standard partial regression coefficient (β)	Standard error	t-value	Adjusted p-value
Neuroticism						
All participants	0.053	0.44	0.060	0.652	0.92	0.36
Men	0.083	0.50	0.138	0.886	1.17	0.25
Women	0.001	0.99	0.018	0.894	0.21	0.83
Extraversion						
All participants	0.129	0.06	0.094	0.788	1.47	0.14
Men	0.247	0.039*	0.194	1.096	1.61	0.11
Women	0.074	0.37	0.069	1.056	0.83	0.41
Openness						
All participants	0.078	0.26	0.031	0.907	0.47	0.64
Men	0.042	0.73	−0.032	1.217	−0.25	0.81
Women	0.076	0.36	0.086	1.278	1.04	0.30
Agreeableness						
All participants	0.077	0.26	0.074	1.033	1.16	0.25
Men	−0.060	0.62	0.021	1.620	0.18	0.86
Women	0.089	0.28	0.119	1.327	1.43	0.16
Conscientiousness						
All participants	0.253	<0.001*	0.158	0.842	2.50	0.013*
Men	0.287	0.016*	0.260	1.177	2.25	0.028*
Women	0.171	0.040*	0.132	1.122	1.61	0.11

In the multivariate analysis, the achievement rate was the objective variable, age and exercise habits were covariates, and personality traits were explanatory variables. Sex was also included as a covariate for all participants. *Statistical significance was set at $p < 0.05$.

Conscientiousness predicted higher achievement rates for exercise therapy for major depression prevention among healthy Japanese male workers and may be effective in paper-based instruction. Further investigation is needed because this study's findings cannot be generalized, as age, race, cultural background, workplace, and method of exercise therapy may have influenced the results.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Ethics Committee of the University of Occupational and Environmental Health, Japan. The patients/participants provided their written informed consent to participate in this study.

Author contributions

AI and RY conceived, designed, and conducted the study. AI and NO analyzed the data. AI, NO, TM, and RY took part in drafting, revising, or critically reviewing the article, gave final approval of the version to be published, agreed on the journal to which the article had been submitted, and agreed to be accountable for all aspects of the work. All authors contributed to the article and approved the submitted version.

Funding

This study was supported and partially funded by a research grant from the University of Occupational and Environmental Health, Japan.

Acknowledgments

The authors would like to thank editage (https://www.editage.jp) for English language editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Alizadeh, Z., Feizi, A., Rejali, M., Afshar, H., Keshteli, A. H., and Adibi, P. (2018). The predictive value of personality traits for psychological problems (stress, anxiety and depression): results from a large population-based study. *J. Epidemiol. Glob. Health* 8, 124–133. doi: 10.1016/j.jegh.2017.11.003

Allen, M. S., Magee, C. A., Vella, S. A., and Laborde, S. (2017a). Bidirectional associations between personality and physical activity in adulthood. *Health Psychol.* 36, 332–336. doi: 10.1037/hea0000371

Allen, M. S., Walter, E. E., and McDermott, M. S. (2017b). Personality and sedentary behavior: a systematic review and meta-analysis. *Health Psychol.* 36, 255–263. doi: 10.1037/hea0000429

Artese, A., Ehley, D., Sutin, A. R., and Terracciano, A. (2017). Personality and actigraphy-measured physical activity in older adults. *Psychol. Aging* 32, 131–138. doi: 10.1037/pag0000158

Corr, P. J., and Matthews, G. (2009). *The Cambridge handbook of personality psychology*. Cambridge: Cambridge University Press.

Department of Health and Social Care (2019). UK chief medical officers' physical activity guidelines. *Physical activity guidelines: UK Chief Medical Officers' report*. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/832868/uk-chief-medical-officers-physical-activity-guidelines.pdf (Accessed March 1, 2023).

Dunn, A. L., Trivedi, M. H., Kampert, J. B., Clark, C. G., and Chambliss, H. O. (2005). Exercise treatment for depression: efficacy and dose response. *Am. J. Prev. Med.* 28, 1–8. doi: 10.1016/j.amepre.2004.09.003

Fukuda, K., and Kobayashi, S. (2011). *Self-rating depression scale manual for Japanese version: Revised and enlarged edition*. Kyoto: Sankyobo, Corp.

Gacek, M., Kosiba, G., Wojtowicz, A., López Sánchez, G. F., and Szalewski, J. (2021). Personality-related determinants of physical activity among polish and Spanish physical education students. *Front. Psychol.* 12:792195. doi: 10.3389/fpsyg.2021.792195

Gong, Y., Shi, J., Ding, H., Zhang, M., Kang, C., Wang, K., et al. (2020). Personality traits and depressive symptoms: the moderating and mediating effects of resilience in Chinese adolescents. *J. Affect. Disord.* 265, 611–617. doi: 10.1016/j.jad.2019.11.102

Hakulinen, C., Elovainio, M., Pulkki-Råback, L., Virtanen, M., Kivimäki, M., and Jokela, M. (2015). Personality and depressive symptoms: individual participant meta-analysis of 10 cohort studies. *Depress. Anxiety* 32, 461–470. doi: 10.1002/da.22376

Hyde, J. S. (2014). Gender similarities and differences. *Annu. Rev. Psychol.* 65, 373–398. doi: 10.1146/annurev-psych-010213-115057

Ikenouchi-Sugita, A., Yoshimura, R., Sugita, K., Hori, H., Yamada, K., Sakaue, M., et al. (2013). The effects of a walking intervention on depressive feelings and social adaptation in healthy workers. *J. UOEH* 35, 1–8. doi: 10.7888/juoeh.35.1

Klimstra, T. A., Noftle, E. E., Luyckx, K., Goossens, L., and Robins, R. W. (2018). Personality development and adjustment in college: a multifaceted, cross-national view. *J. Pers. Soc. Psychol.* 115, 338–361. doi: 10.1037/pspp0000205

Kotov, R., Gamez, W., Schmidt, F., and Watson, D. (2010). Linking "big" personality traits to anxiety, depressive, and substance use disorders: a meta-analysis. *Psychol. Bull.* 136, 768–821. doi: 10.1037/a0020327

Kruisdijk, F., Hopman-Rock, M., Beekman, A. T. F., and Hendriksen, I. J. M. (2020). Personality traits as predictors of exercise treatment adherence in major depressive disorder: lessons from a randomised clinical trial. *Int. J. Psychiatry Clin. Pract.* 24, 380–386. doi: 10.1080/13651501.2020.1787452

Lampinen, P., Heikkinen, R. L., and Ruoppila, I. (2000). Changes in intensity of physical exercise as predictors of depressive symptoms among older adults: an eight-year follow-up. *Prev. Med.* 30, 371–380. doi: 10.1006/pmed.2000.0641

Mammen, G., and Faulkner, G. (2013). Physical activity and the prevention of depression: a systematic review of prospective studies. *Am. J. Prev. Med.* 45, 649–657. doi: 10.1016/j.amepre.2013.08.001

McCrae, R. R., and Costa, P. T. Jr. (1987). Validation of the five-factor model of personality across instruments and observers. *J. Pers. Soc. Psychol.* 52, 81–90. doi: 10.1037/0022-3514.52.1.81

Paffenbarger, R. S. Jr., Lee, I. M., and Leung, R. (1994). Physical activity and personal characteristics associated with depression and suicide in American college men. *Acta Psychiatr. Scand. Suppl.* 89, 16–22. doi: 10.1111/j.1600-0447.1994.tb05796.x

Rhodes, R. E., and Smith, N. E. I. (2006). Personality correlates of physical activity: a review and meta-analysis. *Br. J. Sports Med.* 40, 958–965. doi: 10.1136/bjsm.2006.028860

Scholes, S. (2017). *Health survey for England 2016 physical activity in adults*. Available at: http://healthsurvey.hscic.gov.uk/media/63730/HSE16-Adult-phy-act.pdf (Accessed January 3, 2023).

Serrano, D., Martí-Lluch, R., Cárdenas, M., Solanas, P., Marrugat, J., Vilalta-Franch, J., et al. (2022). Gender analysis of the frequency and course of depressive disorders and relationship with personality traits in general population: a prospective cohort study. *J. Affect. Disord.* 302, 241–248. doi: 10.1016/j.jad.2022.01.088

Shiranaka, Y., Nakazato, K., Gondo, Y., and Takayama, M. (2011). *NEO-PI-R, NEO-FFI manual for the Japanese version: Revised and enlarged edition*. Tokyo: Tokyo shinri, Inc.

Stock, A.-K., and Beste, C. (2015). Conscientiousness increases efficiency of multicomponent behavior. *Sci. Rep.* 5:15731. doi: 10.1038/srep15731

Strickhouser, J. E., Zell, E., and Krizan, Z. (2017). Does personality predict health and well-being? A metasynthesis. *Health Psychol.* 36, 797–810. doi: 10.1037/hea0000475

Teychenne, M., Ball, K., and Salmon, J. (2008). Physical activity and likelihood of depression in adults: a review. *Prev. Med.* 46, 397–411. doi: 10.1016/j.ypmed.2008.01.009

Ueda, N., Suda, A., Nakagawa, M., Nakano, H., Umene-Nakano, W., Ikenouchi-Sugita, A., et al. (2011). Reliability, validity and clinical utility of a Japanese version of the social adaptation self-evaluation scale as calibrated using the Beck depression inventory. *Psychiatry Clin. Neurosci.* 65, 624–629. doi: 10.1111/j.1440-1819.2011.02274.x

Weiss, A., Sutin, A. R., Duberstein, P. R., Friedman, B., Bagby, R. M., and Costa, P. T. Jr. (2009). The personality domains and styles of the five-factor model are related to incident depression in medicare recipients aged 65 to 100. *Am. J. Geriatr. Psychiatry* 17, 591–601. doi: 10.1097/JGP.0b013e31819d859d

Whiteford, H. A., Degenhardt, L., Rehm, J., Baxter, A. J., Ferrari, A. J., Erskine, H. E., et al. (2013). Global burden of disease attributable to mental and substance use disorders: findings from the global burden of disease study 2010. *Lancet* 382, 1575–1586. doi: 10.1016/S0140-6736(13)61611-6

Wilson, K. E., Das, B. M., Evans, E. M., and Dishman, R. K. (2015). Personality correlates of physical activity in college women. *Med. Sci. Sports Exerc.* 47, 1691–1697. doi: 10.1249/MSS.0000000000000570

World Health Organization (2021). *Depression*. Available at: https://www.who.int/news-room/fact-sheets/detail/depression (Accessed February 27, 2022).

Zhao, H., Shi, H., Ren, Z., He, M., Li, X., Li, Y., et al. (2022). Gender and age differences in the associations between personality traits and depressive symptoms among Chinese adults: based on China family panel study. *Health Soc. Care Community* 30, e5482–e5494. doi: 10.1111/hsc.13972

Zung, W. W., Richards, C. B., and Short, M. J. (1965). Self-rating depression scale in an outpatient clinic. Further validation of the SDS. *Arch. Gen. Psychiatry* 13, 508–515. doi: 10.1001/archpsyc.1965.01730060026004

frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 28 September 2023
DOI 10.3389/fpubh.2023.1190464

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OPEN ACCESS

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RECEIVED 02 May 2023
ACCEPTED 11 September 2023
PUBLISHED 28 September 2023

CITATION
Fujino Y, Tokuda F and Fujimoto S (2023) Decreased step count prior to the first visit for MDD treatment: a retrospective, observational, longitudinal cohort study of continuously measured walking activity obtained from smartphones.
Front. Public Health 11:1190464.
doi: 10.3389/fpubh.2023.1190464

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Decreased step count prior to the first visit for MDD treatment: a retrospective, observational, longitudinal cohort study of continuously measured walking activity obtained from smartphones

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Introduction: Major depressive disorder (MDD) is a common debilitating psychiatric condition and a major cause of productivity loss in workers. Using intermittent, subjective indicators, previous studies have shown that physical activity can predict lower levels of depressive symptoms. However, there is an unmet need for continuous and objective measures to identify MDD development before it results in productivity loss. The aim of this study was to elucidate the association between continuously measured walking activity and the development of MDD.

Methods: This retrospective, observational, longitudinal cohort study used health insurance claims data. Individuals aged 20–74 years were included if they had a record of MDD diagnosis and daily step count data for the 60 days before and after the first recorded MDD-related visit, which was defined as the index date. Multivariate analysis was conducted to compare 7-day moving averages of step counts on each day of the analysis period with the mean step count on the index date. Joinpoint regression analysis was used to determine when the trajectory of the moving step count average changed (inflection point).

Results: In total, 2,143 patients with a mean age of 41.2 (standard deviation [SD]: 10.6) years were included. The majority of patients were men (69.5%) and employed full-time (94.1%). Antidepressants were prescribed for 59.2% of patients. The 7-day moving average step count decreased from 6,310 (SD: 3758) at day −60 to 5,879 (SD: 3183) at the index date (first recorded MDD-related visit), and then increased to 6,062 (SD: 4029) at day +60. Compared with the index date, the 7-day moving average of step counts was significantly higher at days −60 to −1, +23 to +33, and + 42 to +60, and significantly lower at days +2 and + 3. Joinpoint regression analysis of 7-day moving average step counts from day −60 to day 0 identified an inflection point at day −14.

Conclusion: In working-age Japanese people, a formal diagnosis of MDD was preceded by a notable decline in daily step counts by approximately 2 weeks. MDD diagnosis and (presumed) treatment were followed by a gradual increase in daily step counts.

KEYWORDS

continuous monitoring, diagnosis, Japanese, major depressive disorder, physical activity, step count, antidepressant

Introduction

The number of people with mental health disorders in Japan continues to increase (1). Major depressive disorder (MDD) is a common and debilitating psychiatric condition. In Japan, the 12-month prevalence estimates for MDD are 2.2% in men and 3.2% in women (2). MDD is characterized by a variety of emotional and physical problems, and is often associated with impaired psychosocial functioning, which typically manifests in productivity loss (3, 4). The overall economic burden associated with MDD in Japan was estimated at approximately $11 billion per year in 2008, of which approximately $7 billion was associated with productivity loss due to presenteeism and absenteeism (5). The proportion of companies in Japan with employees who retired or took leave that lasted more than 1 month owing to mental health issues was 9.2% in 2020, down only slightly from 10.3% in 2013 (1). Mental health disorders are the most common cause of medically certified sick leave lasting 30 days or longer, accounting for 52% of such absences in men and 35% in women (6).

In Japan, a range of measures have been implemented to combat depression among employees, such as discouragement of long working hours, mental health care in the workplace and the Stress Check Program (7–9). Long working hours, traditionally part of Japanese workplace practice, are one of the factors contributing to work-related accidents caused by mental health issues (8, 9). As a result, the practice of working long hours is being discouraged (10). The Stress Check Program has been mandated by law since 2015 for companies with 50 or more employees (7, 11). As part of the Program, employers are required to provide workers with a psychosocial stress questionnaire at least once a year. If the results of the questionnaire suggest that a worker has high stress levels, employers will arrange (if requested by the worker) an interview with an occupational health professional. Employers are required to consider the opinion of the occupational health professional on how the working conditions of employees with high stress may be improved and are prohibited from taking retaliatory actions against such employees (7, 11). In addition to the Stress Check Program, four types of care have been recommended for employees with mental health issues in the workplace: the promotion of mental health awareness among workers, promotion of awareness and response to mental health issues by supervisors (line care), care by occupational health professionals, and care by outside specialists including employee assistance program counselors (12).

As the number of people with mental health disorders continues to increase, the importance of proactively identifying at-risk workers is increasing. Stress checks and line care are aimed at early detection of mental health problems in workers (7, 11). However, stress checks are based on self-reporting and self-assessment by the workers themselves, and line care relies on the subjective judgment of supervisors (7, 11). Therefore, there is an unmet need for continuous and objective methods and techniques to identify mental health problems in workers in a timely manner, before they result in aggravation of symptoms along with productivity loss. However, no such methods have been established so far.

Previous studies have established the connection between physical activity and depressive symptoms (13–16). Evidence from a systematic review of 49 prospective cohort studies ($N = 266,939$ individuals, 1,837,794 person–years) conducted across Asia (including Japan), Europe, North America, and Oceania, found that higher physical activity has protective effects against the development of MDD and depressive symptoms regardless of age or geographic location (16). Indeed, physical activity has a direct antidepressant effect, which is mediated via several physiological and psychosocial pathways (15).

However, in previous studies, physical activity was measured intermittently using a self-reported questionnaire or a pedometer (13, 14, 16). It may be difficult to detect the signs and symptoms of MDD using intermittent, subjective indicators. More recently, smartphones and wearable devices with accelerometer and gyroscope sensors have been developed and are available for the public. Most of these devices are equipped with telecommunication functions that enable automatic collection of real-time data. Therefore, an objective marker that can be continuously monitored using a wearable device may be useful in detecting the signs of MDD prior to a clinical diagnosis. To the best of our knowledge, no study has assessed physical activity before and after MDD diagnosis using objective measures obtained via continuous monitoring.

The present study was conducted to elucidate the association between continuously measured walking activity and the development of MDD. We hypothesized that the diagnosis of MDD would be preceded by a reduction in daily step counts and followed by a recovery of daily step counts due to interventions. If an association between walking activity and MDD development was found, we sought to identify the number of days prior to the diagnosis that this decrease would occur.

Materials and methods

Study design and participants

This was a retrospective, observational, longitudinal cohort study. We used longitudinal data on health insurance claims and routine health examinations from over 550,000 people enrolled in employment insurance at approximately 80 health insurance associations located across various regions of Japan. In addition, daily step count data were collected from over 150,000 of the insured individuals and their dependents who are enrolled in health service apps provided by the health insurance associations. Of these approximately 150,000 individuals, both the health insurance claims and step count data for the period between April 1, 2014 and August 31, 2021 were obtained for 118,161 individuals. Of this number, 6644 individuals were aged 20–74 years and had a record of MDD diagnosis [International Classification of Diseases (ICD) 10 codes F32–F33]. After excluding those without step count data for the 60 days before and after the date of the first recorded MDD-related visit ($n = 3,463$), those with missing step count data on 7 or more consecutive days ($n = 909$), and those with records of cancer (ICD-10 codes C00–C97), bipolar disorder (F31) or dialysis (identified by searching for the term 'dialysis' in Japanese in medical procedure records) ($n = 174$), data from 2,143 patients were available for the present analysis (Figure 1).

Observation and analysis period

Health insurance claims data and step count data for the period between April 2014 and August 2021 and MDD diagnosis data for the period between April 2015 and August 2021 were obtained and analyzed in the present study. For each included individual ($n = 2,143$),

the index date was defined as the date of the first recorded MDD-related visit identified in the health insurance claims data. Step count data were analyzed over a period spanning 60 days before and 60 days after the index date (analysis period), to allow for changes in walking activity to be detected based on the diagnostic criteria for MDD (several symptoms during the same 2-week period) with sufficient sample size.

Assessment of step count

Daily step count data, including the year, month and day when step count data were acquired, were recorded and collected via the Health app (iOS) or Google Fit app (Android), which rely on the smartphone's inbuilt accelerometer. Data on participation in walking campaigns (assessed daily) were also collected via health service apps. Walking campaigns are events in which health insurance associations invite participants to engage in organized walking through the health service apps to promote physical activity in the participants' daily lives. If data were available on the start and end dates of the campaign, all days between the start and end dates were considered as participation days. These data (year and month when step count data were acquired, participation in walking campaigns) were included in a multivariate regression analysis model as covariates (see below).

Other covariates

Data on age, sex, comorbidity, hospitalization events and antidepressant prescriptions were also collected, and were derived from health insurance claims data. Age was calculated by comparing the birth month and year with the month and year of the index date, defined as the date of the first recorded MDD-related visit or, in sensitivity analysis, as the date of the first prescription of antidepressants. The presence of comorbidity (assessed monthly) was defined as having one of the following diseases in the same year, month or week as the step count time window: coronary artery disease (ICD-10 codes I20–I25), diabetes (E10–E14), stroke (I60–I63), chronic lower respiratory tract diseases (J40–J47), arthritis (M00–M13), hypertension (I10–I15), osteoporosis (M80–M82) and fractures

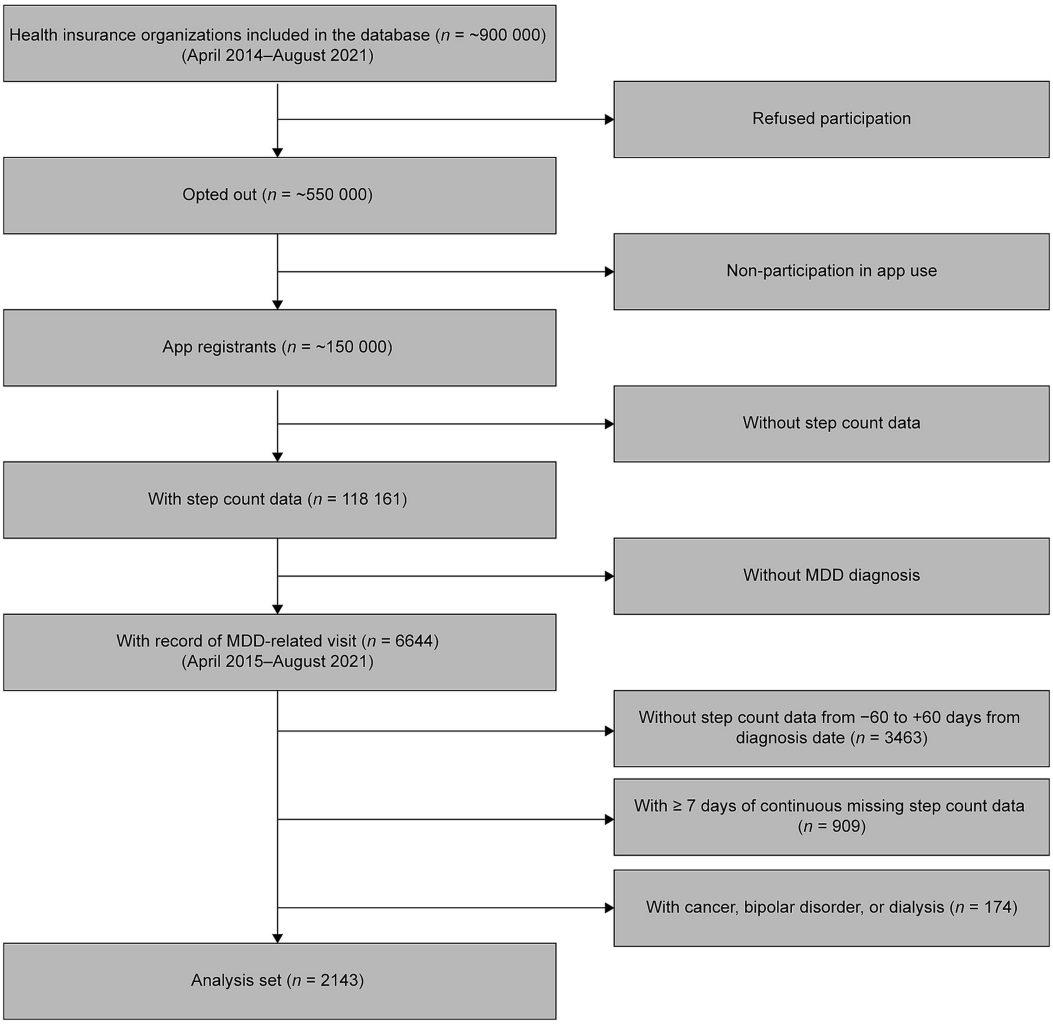

FIGURE 1
Patients included in the analysis. MDD, major depressive disorder.

(S02, S12, S22, S32, S42, S52, S62, S72, S82, S92, T02). Hospitalization events (assessed daily) were identified based on hospitalization costs and were not limited to a specific disease. Prescription of antidepressants was defined as the prescription of any of the following drugs during the analysis period: amitriptyline hydrochloride, amoxapine, clomipramine hydrochloride, dosulepin hydrochloride, duloxetine hydrochloride, escitalopram oxalate, fluvoxamine maleate, imipramine hydrochloride, lofepramine hydrochloride, maprotiline hydrochloride, mianserin hydrochloride, milnacipran hydrochloride, mirtazapine, nortriptyline hydrochloride, paroxetine hydrochloride hydrate, sertraline hydrochloride, setiptiline maleate, trazodone hydrochloride, trimipramine maleate, venlafaxine hydrochloride and vortioxetine hydrobromide. These data (age, sex, comorbidity, hospitalization events and antidepressant prescriptions) were also used as covariates (see below).

Statistical analysis

Demographic and clinical characteristics of included patients were analyzed using summary statistics. For continuous variables, means and standard deviations (SDs) or medians and interquartile ranges were calculated depending on the data distribution. For categorical variables, frequencies and/or percentages were calculated. An alpha level of 0.05 was used when testing for statistical significance.

The 7-day moving average of step counts was calculated for each day of the analysis period. Step counts on the index date were excluded from the calculation, as were step counts on days when fewer than 50 steps were recorded, on the assumption that fewer than 50 steps would indicate that the individual was not carrying a smartphone on that day. Missing data were not imputed. Days for which step count data were not available were excluded from the moving average calculation.

Multivariate regression analysis was conducted using generalized estimating equations (GEEs) to compare 7-day moving averages of step counts on each day with the mean step count on the index date. For GEEs, a binomial distribution (log link) was specified as a fixed value for the error structure, and the Quasi-Likelihood Information Criterion (QIC) selected autoregressive (smallest QIC score) for the correlation structure. Covariates (age, sex, comorbidity, year and month when step count data were acquired, participation in walking campaigns, hospitalization events and antidepressant prescriptions) were included in the model to correct for potential confounding. The duration of participation in walking campaigns was included as a covariate, because the number of steps was likely to be affected by participation in such campaigns.

Joinpoint regression analysis was used to determine when the trajectory of the moving step count average changed. In a joinpoint regression analysis, lines representing data trends on a graph are converted into a series of straight lines linked at joinpoints (17). The minimum and maximum number of joinpoints are provided by researchers. Analysis begins with the minimum number of joinpoints specified. The model is then built by gradually increasing the number of joinpoints, until the maximum specified number is reached. How well each model fits the data is compared using the Monte Carlo Permutation method, and the model with the best fit is selected. The location of joinpoints corresponds to statistically significant changes in the trajectory of the data trend (inflection points) (17). In the present study, the minimum and maximum number of joinpoints were set at 0 and 1, respectively. If the model containing 1 joinpoint fits the data better than the model containing 0 joinpoints, then the location of the joinpoint would be considered the inflection point.

In addition to the main analysis, subgroup analyses were conducted according to age at the index date (< 40 vs. ≥ 40 years old), sex (male vs. female) and type of health insurance plan (own plan vs. on a family member's plan as a dependent). The effects of age and sex on the level of physical activity are well established (18). Subgroup analysis by type of health insurance plan was conducted because we hypothesized that individuals on their own plan would be more likely to have an active social life and, as a result, take more steps until immediately before the index date compared with individuals on a family member's plan. This would be reflected in a greater change in the number of steps around the index date in participants on their own plan than in participants on a family member's plan. Furthermore, a sensitivity analysis using the first prescription of antidepressants as the index date was performed.

Analyses were performed using SAS software, version 9.4 (SAS Institute, Cary, North Carolina, United States). Joinpoint regression analysis was performed using Joinpoint Regression Program, version 4.9.1.0 (US National Institutes of Health, Bethesda, Maryland, United States).

Compliance with ethics guidelines

This study was based on anonymized administrative claims data that did not involve patients directly. Thus, ethics approval and informed consent were not required, per the Ethical Guidelines for Medical Research Involving Human Subjects issued by the Japanese Ministry of Health, Labor and Welfare.

Results

Patient characteristics

Among the 2,143 patients included in the present study, the proportion of men (69.5%) was higher than the proportion of women (30.5%) (Table 1). The mean age of included patients was 41.2 (SD: 10.6) years. Most patients were on their own health insurance plan (94.1%) and over half (59.2%) were prescribed antidepressants during the analysis period. The most common comorbidities were hypertension (12.1%), chronic lower respiratory disease (11.6%) and diabetes mellitus (6.7%). Few patients had conditions that could have affected their step counts, such as bone fractures, osteoporosis or arthritis (< 3% per condition) (Table 1).

Step counts before and after the index date (main analysis)

A notable decline in mean daily step counts occurred in the 2 weeks before the index date. After the index date, mean daily step counts increased slowly, with differences versus the index date becoming significant after approximately 1 month (Figure 2).

The 7-day moving average step count decreased from 6,310 (SD: 3758) at day −60 to 5,879 (SD: 3183) at the index date, and then

increased to 6,062 (SD: 4029) at day +60 (Table 2). The index date-adjusted moving average step count was 431.5 (SD: 3148) at day −60, decreasing to negative values at days +1 to +6, +10 and + 12, before increasing to 183.6 (SD: 3570) at day +60 (Table 2 and Figure 2).

The results of the multivariate GEE model analysis showed that, compared with the index date, the 7-day moving average step counts were significantly higher at days −60 to −1, +23 to +33 and + 42 to +60, and significantly lower at days +2 and + 3 (Figure 2).

Joinpoint regression analysis of 7-day moving average step counts from day −60 to day 0 identified an inflection point at day −14 (Figure 3).

Subgroup analyses of patients aged <40 years versus ≥40 years, men versus women, and patients on their own health insurance plan versus those on a family member's plan as a dependent generally produced similar findings to the main analysis (Figure 4). The exception was the subgroup of patients who were on a family member's healthcare plan as a dependent ($n = 126$). In this subgroup, no significant differences in daily step counts compared with the index date were detected at any point during the analysis period (Figure 4).

Step counts before and after first antidepressant use (sensitivity analysis)

Using the date of the first antidepressant prescription (instead of the date of the first record of MDD diagnosis) as the index date identified a total of 2022 patients who were included in the sensitivity analysis. Patients' characteristics, the overall trajectory of mean step counts and results of the multivariate GEE model analysis in the sensitivity analysis were similar to those in the main analysis (data on file).

TABLE 1 Characteristics of included patients.

Characteristic	*N* = 2,143
Age, mean ± SD (range)	41.2 ± 10.6 (18–70)
< 40 years, *n* (%)	905 (42.2)
≥ 40 years, *n* (%)	1,238 (57.8)
Men, *n* (%)	1,489 (69.5)
CCI, mean ± SD (range)	0.5 ± 0.8 (0–8)
Health insurance type, *n* (%)	
Own plan	2017 (94.1)
Dependent family member	126 (5.9)
Patients with events during the analysis period, *n* (%)	
Walking campaign	244 (11.4)
Hospitalization	67 (3.1)
Prescription of antidepressants[a]	1,268 (59.2)
Comorbidities, *n* (%)	
Coronary artery diseases	54 (2.5)
Diabetes	144 (6.7)
Stroke	22 (1.0)
Chronic lower respiratory diseases	249 (11.6)
Arthritis	57 (2.7)
Hypertension	259 (12.1)
Osteoporosis	22 (1.0)
Fracture	21 (1.0)

[a]Assessed during the analysis period.
CCI, Charlson comorbidity index; SD, standard deviation.

Effects of model covariates on step counts

Of the covariates included in the multivariate model assessing step counts before and after the index date (main analysis; $N = 2,143$), age 40 years or older ($Z = -2.39$, $p = 0.017$), coronary artery disease ($Z = -2.80$, $p = 0.005$), arthritis ($Z = -2.57$, $p = 0.010$), hospitalization ($Z = -6.36$, $p = 0.000$) and prescription of antidepressants ($Z = -3.11$, $p = 0.002$) were independently associated with lower mean step counts during the study period, whereas male sex ($Z = 11.76$, $p = 0.000$) was associated with higher mean step counts. Mean step counts were also significantly higher in March ($Z = 2.01$, $p = 0.044$) and April ($Z = 2.87$, $p = 0.004$) versus December, and in 2015–2020 ($Z = 2.99$–4.07, $p = 0.000$–0.003) versus 2021.

Discussion

This study examined the relationship between MDD and physical activity in the form of daily step counts. The results show a sharp decline in daily step counts during the 14 days before the patients' first recorded MDD-related visit (index date). Following the index date, daily step counts increased gradually, but did not fully recover during the 60-day period analyzed.

To the best of our knowledge, this study is the first to show, using objective measurements, that decreased step count can be a prodromal symptom of depression. Although being able to predict the onset of depression has attracted the interest of clinicians (19, 20), information on individuals before diagnosis is lacking because most clinical studies have focused on investigating symptoms or outcomes of interventions in diagnosed patients. Prodromal symptoms are often only determined by the physician retrospectively at diagnosis. In fact, there are no available means to confirm prodromal symptoms before diagnosis. Thus, this is a breakthrough study in that it used step count data, which can be routinely obtained from workers over time, to determine change prior to diagnosis.

The results of the joinpoint regression analysis suggest a sharp decline in step counts 2 weeks prior to the first recorded MDD-related visit. This trend may be attributed to a loss of interest and motivation, which is consistent with the criteria for the diagnosis of MDD provided in the Diagnostic and Statistical Manual of Mental Disorders, fifth edition, text revision (21). Markedly diminished interest or pleasure in most activities can lead to behavioral apathy and a reduction in the daily physical activity level before MDD diagnosis. Despite the onset of depressive symptoms, Japanese people tend to wait a relatively long time before seeking medical support owing to the stigma associated with mental health issues in Japan (22). The resulting exacerbation of depressive symptoms and increased mental distress are likely to cause patients to seek help from their physicians.

This study showed a gradual recovery in daily step counts after the first visit for MDD treatment, suggesting that recovery of some physical activity occurs relatively quickly after MDD diagnosis and

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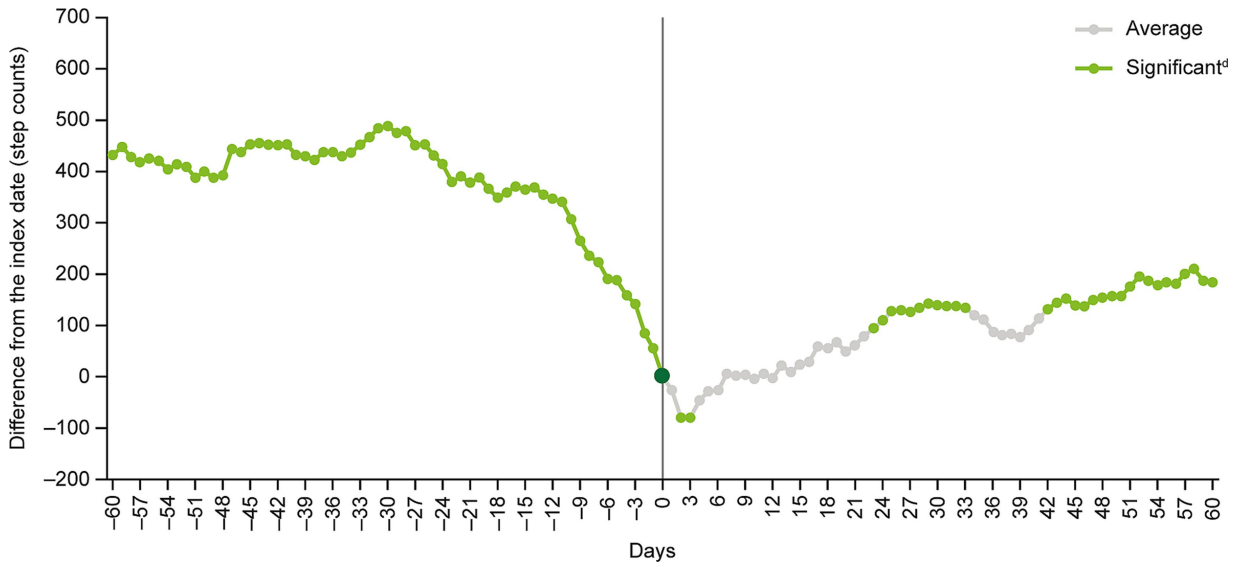

FIGURE 2
Multivariate analysis[a] of moving average step counts[b] before and after the index date[c]. [a]Covariates were age, sex, year and month when step count data were acquired, participation in a walking campaign, hospitalization event, prescription of antidepressants during the analysis period and presence of comorbidity (coronary artery diseases, diabetes, stroke, chronic lower respiratory diseases, arthritis, hypertension, osteoporosis, fracture). [b]The moving average of step counts was calculated after subtracting the number of steps on day 0 (i.e., the index date) from the 7-day moving average for each day at the individual level. [c]The index date (day 0) was defined as the date of the first recorded MDD-related visit identified from health insurance claims data. [d]Step count changes around the index date were examined by inspecting the statistical significance of regression coefficients corresponding to each time point. MDD, major depressive disorder.

TABLE 2 Daily step counts during the analysis period.

Day[a]	*n*	Moving mean[b]	SD	Median	Difference from index date[c]			Multivariate analysis[d]		
					Moving mean[b]	SD	Median	Estimates	95% CI	*p* value
−60	2,143	6,310	3,758	5,903	432	3,148	248	1.07	1.04–1.09	0.000
−50	2,143	6,278	3,367	5,944	400	2,729	291	1.06	1.04–1.08	0.000
−40	2,143	6,310	3,230	6,039	432	2,607	311	1.07	1.05–1.09	0.000
−30	2,143	6,367	3,245	6,025	488	2,621	317	1.08	1.06–1.10	0.000
−20	2,143	6,267	3,132	5,899	389	2,503	209	1.06	1.05–1.08	0.000
−15	2,143	6,242	3,073	5,971	364	2,419	250	1.06	1.04–1.08	0.000
−10	2,143	6,184	3,152	5,857	306	2,367	221	1.05	1.04–1.07	0.000
−5	2,143	6,067	3,065	5,772	188	1789	118	1.03	1.02–1.05	0.000
−1	2,143	5,935	3,175	5,740	56	738	11	1.01	1.00–1.02	0.000
0[e]	2,143	5,879	3,183	5,596	Reference			Reference		
1	2,143	5,853	3,228	5,462	−26	777	−8	1.00	0.99–1.00	0.122
10	2,143	5,874	32,435	5,590	−4	2,293	15	1.00	0.98–1.02	0.994
20	2,143	5,928	3,193	5,591	49	2,535	49	1.01	0.99–1.03	0.274
30	2,143	6,018	3,675	5,631	140	2,959	62	1.03	1.00–1.05	0.017
40	2,143	5,969	3,584	5,535	90	2,943	47	1.02	1.00–1.04	0.101
50	2,143	6,035	3,904	5,595	157	3,318	46	1.03	1.00–1.05	0.018
60	2,143	6,062	4,029	5,700	184	3,570	70	1.04	1.01–1.06	0.006

[a]Daily data were used in the analysis, however, only the results for every 10 days are shown here.
[b]7-day moving mean.
[c]The mean and median were calculated after subtracting the number of steps on day 0 from the 7-day moving average for each day at the individual level.
[d]Covariates were age, sex, year and month when step count data were acquired, participation in a walking campaign, hospitalization event, prescription of antidepressants during the analysis period and presence of comorbidity (coronary artery diseases, diabetes, stroke, chronic lower respiratory diseases, arthritis, hypertension, osteoporosis, fracture).
[e]The index date was defined as the date of the first recorded MDD-related visit identified from health insurance claims data.
CI, confidence interval; SD, standard deviation.

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Model selection method	
Cohort	Model selection method
0	Permutation test

Test for number of joinpoints								
Cohort	Test number	Null hypothesis	Alternate hypothesis	Number of degrees of freedom	Denominator degrees of freedom	Number of permutations	*p* value	Significance level[a]
0	1	0 joinpoints	1 joinpoint[b]	2	56	10 001	0.0001000	0.0500000
Final selected model: 0–1 joinpoint(s)								

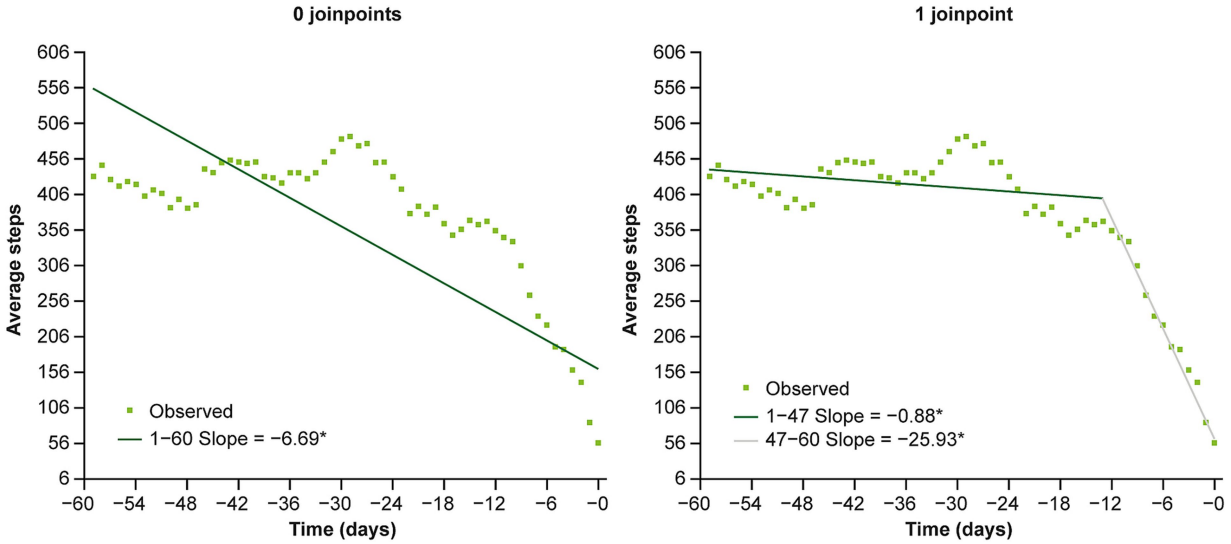

FIGURE 3
Results of joinpoint regression analysis. [a]Significance level for individual test. [b]Final selected model. *The slope is significantly different from 0 at the alpha level of 0.05.

(presumed) treatment. However, after 60 days, the number of daily steps had not fully recovered to pre-treatment levels. The proportion of patients with MDD who achieve symptomatic remission within 4 weeks of treatment with antidepressants has been shown to be 15–25%, with an increase up to 40% observed in the following few weeks (23). Treatment efficacy may differ depending on the antidepressant drug and disease severity, however, full recovery of step counts could not be expected for patients after 60 days of treatment (24). It has been reported that it takes about a year for workers receiving antidepressants to return to previous levels of work productivity (25). Furthermore, cognitive function has been shown to be impaired even after remission and several years are needed for recovery to control levels (26, 27). In addition, workers may need an even longer period of time for full recovery of step counts if the primary mode of intervention is to reduce working hours, reduce physically demanding tasks, or to take a leave of absence after a diagnosis of depression.

An important strength of this study is the continuous collection of daily step count data from a large number of working-age individuals prior to their first visit for MDD, as well as after the diagnosis. The development of wearable devices has enabled us to monitor physical activity constantly and objectively, without any subjective biases. Our results suggest that step count data could be used to proactively detect MDD onset in the working-age population, which has the potential to lead to early interventions, and therefore, to reductions in productivity loss and the social burden imposed by MDD. Further research is needed to determine whether the approach of continuously monitoring step counts via wearable devices can be sufficiently refined to improve the rates of MDD diagnosis and to optimize subsequent interventions. Because MDD is a heterogenous disease with various physical phenotypes, a combination of methods such as step count data, other objective markers and machine learning, would be required to identify individuals at risk of MDD development in advance and to prevent the disease (28, 29).

This study has several limitations. First, recruitment was limited to individuals enrolled in employment health insurance who used a health service app. As a result, the population examined is not entirely representative of all patients with MDD who have employment health insurance or of Japanese patients with MDD in general. Second, the accuracy of the step counts recorded by the app could not be validated. Several previous studies found that step counts recorded by smartphone apps are generally reliable; however, this varies significantly depending on the app used (30–32). However, this study

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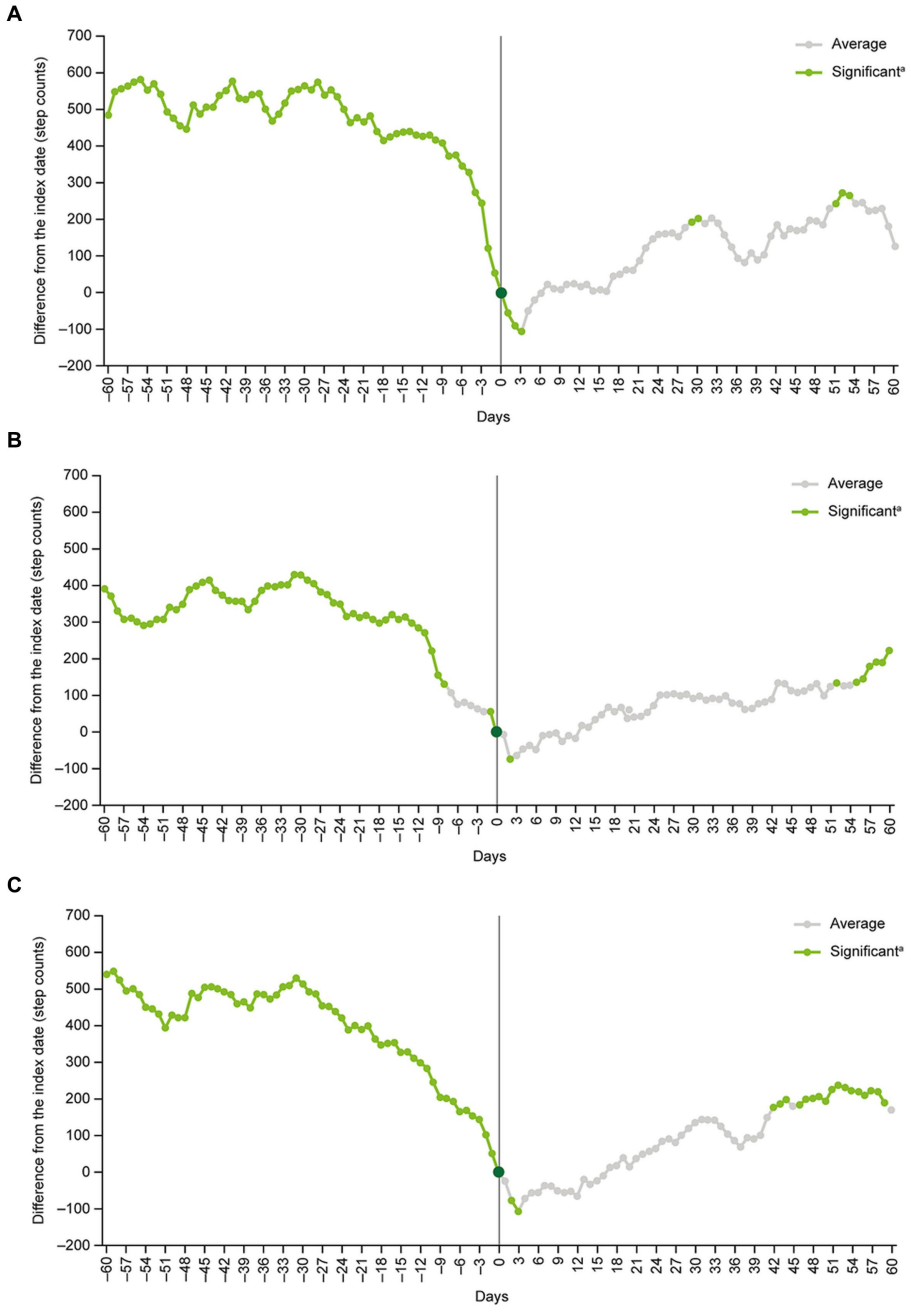

FIGURE 4 (Continued)

focused on intraindividual changes in daily step counts, and individual participants probably used the same application throughout the study period. Therefore, we believe that the effect of varying app accuracy on the results of this study was minimal. Third, the methodology did not allow us to distinguish between the first MDD diagnosis and a recurrence, or between working and non-working days, although the use of a 7-day moving average for step counts should partially address the latter limitation. Lastly, the health insurance claims data that were used in the present study did not include information about patients' disease severity and treatment outcomes. Thus, we could not examine whether there was a correlation between step counts and severity of depressive symptoms.

In conclusion, this study found that among working-age individuals in Japan, a formal diagnosis of MDD was preceded by a notable decline in daily step counts over a period of approximately 2 weeks and was followed by a gradual increase in daily step counts after MDD diagnosis and (presumed) treatment. These results provide a foundation for further research on how to predict and prevent the development of MDD in the working-age population.

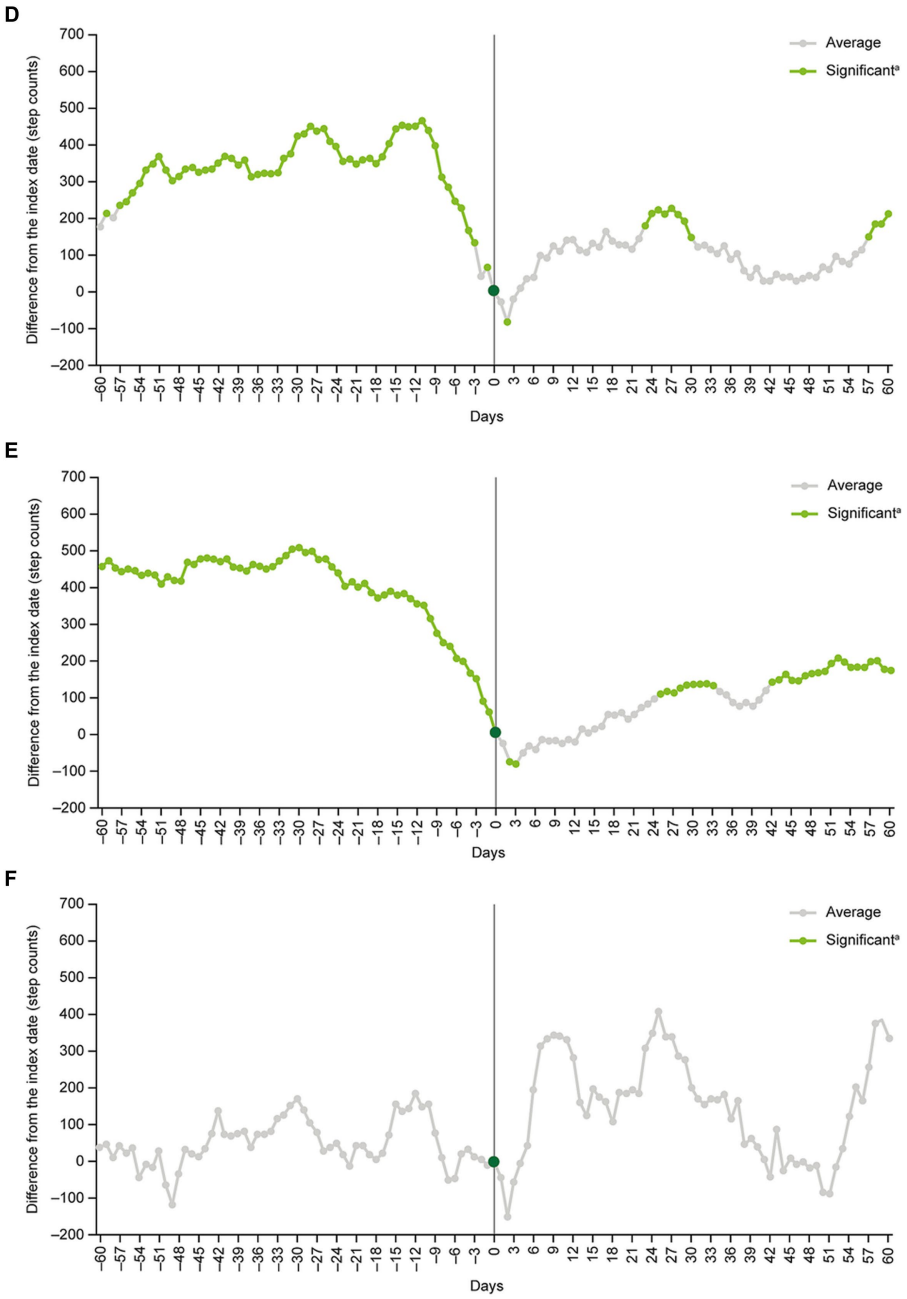

FIGURE 4
Subgroup analyses in **(A)** patients <40 years old, **(B)** patients ≥40 years old, **(C)** men, **(D)** women, **(E)** patients on their own health insurance plan, and **(F)** patients on a family member's health insurance plan as a dependent. [a]Step count changes around the index date were examined by inspecting the statistical significance of regression coefficients corresponding to each time point.

Data availability statement

The original contributions presented in the study are included in the article/supplementary materials, further inquiries can be directed to the corresponding author.

Ethics statement

Ethical approval was not required for the study involving humans in accordance with the local legislation and institutional requirements. Written informed consent to participate in this study was not required from the participants or the participants' legal guardians/next of kin in accordance with the national legislation and the institutional requirements.

Author contributions

YF, FT, and SF contributed to the study design and interpretation of study results, and were involved in the drafting, critical revision, and approval of the final version of the manuscript. All authors contributed to the article and approved the submitted version.

Funding

This study was sponsored by the Takeda Pharmaceutical Company Limited, the manufacturer/licensee of the antidepressant vortioxetine.

Acknowledgments

The authors thank Hisato Deguchi, of Takeda Pharmaceutical Company Limited, for designing the study plan and clarifying the research questions by leading internal discussions; Keita Fujikawa, of Takeda Pharmaceutical Company Limited, for study overview; Deloitte Touche Tohmatsu LLC for providing support with statistical analyses; and DeSC Healthcare, Inc., from whom access to the DeSC health insurance claims database was purchased. The authors thank Georgii Filatov and Michael Molloy-Bland, PhD, of Oxford PharmaGenesis, Melbourne, Australia for providing medical writing support, funded by Takeda Pharmaceutical Company Limited, in accordance with Good Publication Practice (GPP) guidelines (https://www.ismpp.org/gpp-2022').

Conflict of interest

FT and SF are employees of Takeda Pharmaceutical Company Limited. YF has a consulting service agreement with Takeda Pharmaceutical Company Limited and receives consulting fees.

The authors declare that this study received funding from Takeda Pharmaceutical Company Limited. The funder had the following involvement: contribution to the study design and interpretation of the study results, involvement in the decision to submit, critical review of the manuscript, and approval of the final version for submission. All authors declare no other competing interests.

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References

1. Ministry of Health, Labor and Welfare of Japan. (2020). Occupational Safety and Health Survey. Available at: https://www.mhlw.go.jp/toukei/list/r04-46-50.html (Accessed November 14, 2022).

2. Nishi D, Ishikawa H, Kawakami N. Prevalence of mental disorders and mental health service use in Japan. *Psychiatry Clin Neurosci*. (2019) 73:458–65. doi: 10.1111/pcn.12894

3. Lam RW, Kennedy SH, McLntyre RS, Khullar A. Cognitive dysfunction in major depressive disorder: effects on psychosocial functioning and implications for treatment. *Can J Psychiatr*. (2014) 59:649–54. doi: 10.1177/070674371405901206

4. Sumiyoshi T, Watanabe K, Noto S, Sakamoto S, Moriguchi Y, Tan KHX, et al. Relationship of cognitive impairment with depressive symptoms and psychosocial function in patients with major depressive disorder: cross-sectional analysis of baseline data from perform-J. *J Affect Disord*. (2019) 258:172–8. doi: 10.1016/j.jad.2019.07.064

5. Okumura Y, Higuchi T. Cost of depression among adults in Japan. *Prim Care Companion CNS Disord*. (2011) 13. doi: 10.4088/PCC.10m01082

6. Nishiura C, Nanri A, Kashino I, Hori A, Kinugawa C, Endo M, et al. Age-, sex-, and diagnosis-specific incidence rate of medically certified long-term sick leave among private sector employees: the Japan epidemiology collaboration on occupational health (J-Ecoh) study. *J Epidemiol*. (2017) 27:590–5. doi: 10.1016/j.je.2017.01.003

7. Kawakami N, Tsutsumi A. The stress check program: a new National Policy for monitoring and screening psychosocial stress in the workplace in Japan. *J Occup Health*. (2016) 58:1–6. doi: 10.1539/joh.15-0001-ER

8. Okamoto S. Hours of work and health in Japan. *Ann Epidemiol*. (2019) 33:64–71. doi: 10.1016/j.annepidem.2019.02.003

9. Yamauchi T, Sasaki T, Takahashi K, Umezaki S, Takahashi M, Yoshikawa T, et al. Long working hours, sleep-related problems, and near-misses/injuries in industrial settings using a nationally representative sample of Workers in Japan. *PLoS One*. (2019) 14:e0219657. doi: 10.1371/journal.pone.0219657

10. Iwasaki K, Takahashi M, Nakata A. Health problems due to long working hours in Japan: working hours, workers' compensation (Karoshi), and preventive measures. *Ind Health*. (2006) 44:537–40. doi: 10.2486/indhealth.44.537

11. Mishiba T. The background and current state of implementing a legal system for stress checks in Japan. *Ind Health*. (2022) 60:183–95. doi: 10.2486/indhealth.2021-0090

12. Inoue K. Corporation with the workplace that take four levels of care into consideration. *Seishin Shinkeigaku Zasshi*. (2021) 123:81–6.

13. Fukukawa Y, Nakashima C, Tsuboi S, Kozakai R, Doyo W, Niino N, et al. Age differences in the effect of physical activity on depressive symptoms. *Psychol Aging*. (2004) 19:346–51. doi: 10.1037/0882-7974.19.2.346

14. Lindwall M, Larsman P, Hagger MS. The reciprocal relationship between physical activity and depression in older European adults: a prospective cross-lagged panel design using share data. *Health Psychol*. (2011) 30:453–62. doi: 10.1037/a0023268

15. Kandola A, Ashdown-Franks G, Hendrikse J, Sabiston CM, Stubbs B. Physical activity and depression: towards understanding the antidepressant mechanisms of physical activity. *Neurosci Biobehav Rev*. (2019) 107:525–39. doi: 10.1016/j.neubiorev.2019.09.040

16. Schuch FB, Vancampfort D, Firth J, Rosenbaum S, Ward PB, Silva ES, et al. Physical activity and incident depression: a meta-analysis of prospective cohort studies. *Am J Psychiatry*. (2018) 175:631–48. doi: 10.1176/appi.ajp.2018.17111194

17. Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression with applications to cancer rates. *Stat Med*. (2000) 19:335–51. doi: 10.1002/(sici)1097-0258(20000215)19:3<335::aid-sim336>3.0.co;2-z

18. WHO. *Global action plan on physical activity 2018–2030: more active people for a healthier world*. Geneva: World Health Organization (2018). 2018 p.

19. Kennis M, Gerritsen L, van Dalen M, Williams A, Cuijpers P, Bockting C. Prospective biomarkers of major depressive disorder: a systematic review and meta-analysis. *Mol Psychiatry*. (2020) 25:321–38. doi: 10.1038/s41380-019-0585-z

20. Fu Z, Brouwer M, Kennis M, Williams A, Cuijpers P, Bockting C. Psychological factors for the onset of depression: a meta-analysis of prospective studies. *BMJ Open*. (2021) 11:e050129. doi: 10.1136/bmjopen-2021-050129

21. American Psychiatric Association. *Diagnostic and statistical manual of mental disorders*. (5th ed). Text Revision American Psychiatric Association. (2022).

22. Wang PS, Angermeyer M, Borges G, Bruffaerts R, Tat Chiu W, Girolamo GDE, et al. Delay and failure in treatment seeking after first onset of mental disorders in the World Health Organization's world mental health survey initiative. *World Psychiatry*. (2007) 6:177–85.

23. Szegedi A, Jansen WT, van Willigenburg AP, van der Meulen E, Stassen HH, Thase ME. Early improvement in the first 2 weeks as a predictor of treatment outcome in patients with major depressive disorder: a meta-analysis including 6562 patients. *J Clin Psychiatry*. (2009) 70:344–53. doi: 10.4088/jcp.07m03780

24. Cipriani A, Furukawa TA, Salanti G, Chaimani A, Atkinson LZ, Ogawa Y, et al. Comparative efficacy and acceptability of 21 antidepressant drugs for the acute treatment of adults with major depressive disorder: a systematic review and network meta-analysis. *Lancet*. (2018) 391:1357–66. doi: 10.1016/S0140-6736(17)32802-7

25. Nagata T, Fujino Y, Ohtani M, Fujimoto K, Nagata M, Kajiki S, et al. Work functioning impairment in the course of pharmacotherapy treatment for depression. *Sci Rep*. (2020) 10:15712. doi: 10.1038/s41598-020-72677-1

26. Maeshima H, Baba H, Nakano Y, Satomura E, Namekawa Y, Takebayashi N, et al. Time course for memory dysfunction in early-life and late-life major depression: a longitudinal study from the Juntendo University mood disorder project. *J Affect Disord*. (2013) 151:66–70. doi: 10.1016/j.jad.2013.05.050

27. Semkovska M, Quinlivan L, O'Grady T, Johnson R, Collins A, O'Connor J, et al. Cognitive function following a major depressive episode: a systematic review and meta-analysis. *Lancet Psychiatry*. (2019) 6:851–61. doi: 10.1016/S2215-0366(19)30291-3

28. Chikersal P, Doryab A, Tumminia MJ, Villalba DK, Dutcher JM, Liu X, et al., Detecting depression and predicting its onset using longitudinal symptoms captured by passive sensing: a machine learning approach with robust feature selection. *ACM Trans Comput Hum Interact* (2021) 28::1–3:41. doi: 10.1145/3422821

29. Saito T, Suzuki H, Kishi A. Predictive modeling of mental illness onset using wearable devices and medical examination data: machine learning approach. Frontiers in digital. *Health*. (2022) 4:4. doi: 10.3389/fdgth.2022.861808

30. Case MA, Burwick HA, Volpp KG, Patel MS. Accuracy of smartphone applications and wearable devices for tracking physical activity data. *JAMA*. (2015) 313:625–6. doi: 10.1001/jama.2014.17841

31. Balto JM, Kinnett-Hopkins DL, Motl RW. Accuracy and precision of smartphone applications and commercially available motion sensors in multiple sclerosis. *Mult Scler J Exp Transl Clin*. (2016) 2:2055217316634754. doi: 10.1177/2055217316634754

32. Parmenter B, Burley C, Stewart C, Whife J, Champion K, Osman B, et al. Measurement properties of smartphone approaches to assess physical activity in healthy young people: systematic review. *JMIR Mhealth Uhealth*. (2022) 10:e39085. doi: 10.2196/39085

frontiers | Frontiers in Psychology

TYPE Original Research
PUBLISHED 11 January 2024
DOI 10.3389/fpsyg.2023.1255880

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OPEN ACCESS

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RECEIVED 10 July 2023
ACCEPTED 22 December 2023
PUBLISHED 11 January 2024

CITATION
Zhao X-Y and Zheng S-J (2024) The effect of peer victimization on adolescents' revenge: the roles of hostility attribution bias and rumination tendency.
Front. Psychol. 14:1255880.
doi: 10.3389/fpsyg.2023.1255880

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The effect of peer victimization on adolescents' revenge: the roles of hostility attribution bias and rumination tendency

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Although previous studies revealed that peer victimization was closely related to revenge, mechanisms underlying this association have been unclear. The purpose of this study is to examine the mediating role of hostility attribution bias (HAB) and the moderating role of rumination tendency in the relationship between peer victimization and revenge. The data were collected from 6,622 adolescents. The PROCESS macro of SPSS 26.0 was used to examine the hypotheses. The results show that peer victimization positively associates with revenge. Hostile attribution bias play a partial mediating role between peer victimization and revenge. Both the direct effect of peer victimization on revenge and the first half of the mediating effect of HAB are moderated by rumination tendencies. Specifically, both direct and indirect effects of peer victimization on revenge are stronger in individuals with concrete experiential rumination (CER) tendency than in those with abstract analytic rumination (AAR) tendency.

KEYWORDS

peer victimization, revenge, hostile attribution bias, rumination tendency, abstract analytic rumination, concrete experiential rumination

1 Introduction

Peer victimization refers to the experience of individual encounter from peer aggression, including physical aggression, verbal aggression, relationship aggression and property aggression (Mynard and Joseph, 2000; Zhang et al., 2009). Several studies based on large samples have found that peer victimization is common among adolescents. Furthermore, peer victimization has emerged as a global public health issue (Xiao et al., 2023). The victim's revenge is a deliberate counterattack against the perpetrator and is a type of retaliatory infringement (McCullough, 2017). Revenge is continual and more destructive than other attacks. Revenge against the perpetrator causes a stronger counterattack, which creates a vicious circle and a long-term vendetta (Li and Feng, 2010). Revenge is a global phenomenon and is implicated as a causal factor in many homicides worldwide. Across the United States, revenge is implicated in as many as 61% of school shootings (Jackson et al., 2019). Revenge can drive victim to join terrorist groups and is one of the leading causes of regional conflicts around the world (Chen et al., 2016). To prevent adolescents from breaking the law for revenge, it is necessary to explore the formation mechanism of revenge. This will help to prevent adolescents who have experienced peer victimization changing from "victims" to "perpetrators."

Previous studies have explored the relationship between peer victimization and general aggressive behavior of adolescents from different perspectives, such as adolescents' negative companionship (Chen, 2019), unmet psychological needs (Wang et al., 2020), and lack of parental supervision (Ye et al., 2018). However, revenge is a special type of reactive aggression, which is usually an individual's deliberate counterattack against an perpetrators. Revenge is planned and delayed. Cognitive factors play a central role in maintaining revenge and are stable across time and context (Rowell Huesmann, 1988; Crick and Dodge, 1994). Therefore, this study analyzes the path and conditions of the relationship between peer victimization and adolescent revenge from a cognitive perspective. The results of the study will contribute to the prevention and intervention of adolescent revenge.

1.1 Relationship between peer victimization and adolescent revenge

Revenge is a means of self-protection chosen by an individual who has been victimized, as well as a compensatory mechanism in the hope of making up for the loss of dignity as a result of the violation (Li and Feng, 2010). A recent meta-analytic study found that peer victimization is not only strongly associated with perpetration, but it is also a risk factor for future violation (Walters, 2020). Relevant studies have shown that in order to maintain dignity, regain social status and satisfy certain psychological needs, the victim tries to reduce the negative emotions associated with peer victimization by retaliating against the bully (Ye et al., 2018). When individuals feel humiliated, revenge is seen as a way to restore dignity and regain control of the situation (Fitness, 2001).

1.2 The mediating role of hostile attribution bias

Hostile attribution bias (HAB) refers to the cognitive propensity of individuals to view the behavioral motives of others in ambiguous circumstances as intentional to harm themselves (Dodge, 2006). Previous research has shown that hostile attribution bias predicts reactive aggression and is an important cognitive factor in the formation and development of reactive aggression (Crick and Dodge, 1996). However, there is a lack of research specifically on the link between HAB and revenge.

According to social information processing theory, when individuals process new information, they spontaneously interpret it using experiences related to it in memory, providing *a priori* experiences, and ndividuals' interpretations of social situations affect their subsequent behavior (Crick and Dodge, 1994; Xiang et al., 2022). Empirical research supports the notion that peer victimization causes individuals to construct schemas of distrust, and such distrustful schemas can cause adolescents to interpret their peers' intentions hostilely in ambiguously provocative situations (Li et al., 2021). After perceiving provocation, adolescents interprete the provocative behavior as being hostile, which is significantly associated with seeking revenge (Smalley and Banerjee, 2014). The tracking study shows that peer victimization changes preadolescent children's psychological structures, leading to the formation of HBA, which leads to future aggressive behavior (Yao and Enright, 2021). Therefore, Adolescents who suffer from peer victimization perceive harm in interpersonal communication, which provides prior experience for their judgment of interpersonal events. These prior experiences can lead to hostile attribution bias in adolescents, which in turn prompts them to resort to revenge to protect themselves.

1.3 The moderating role of rumination tendency

Cognitive strategies are a way for individuals to view and understand emotional events and can significantly affect their emotional and behavioral responses (Chawla and Ostafin, 2007; Zhang, 2020). Studies have confirmed that adolescents' coping strategies for emotional events gradually shift from external behavioral orientation to internal cognitive orientation (Luo et al., 2010; Xu, 2014). As a cognitive coping strategy, rumination plays an important role in adolescents' cognitive evaluation and behavioral response to peer victimization. However, rumination is largely recognized as maladaptive in existing research, but such studies have been conducted primarily in Western contexts (Choi and Miyamoto, 2023). A growing body of cross-cultural research suggests that there are cultural differences in the frequency of rumination and its relationship to psychological outcomes (Chang et al., 2010; Kwon et al., 2013). The maladaptive effects of rumination may be weaker in Eastern than in Western cultural contexts (Choi and Miyamoto, 2023). Based on this, this study explores the role of rumination tendency in the relationship between peer victimization and adolescent revenge in the Chinese cultural context.

Rumination is the repeated thinking about negative events and their causes and consequences. Rumination can be divided into abstract analytic rumination (AAR) and concrete experiential rumination (CER) based on the processing method (Denson, 2013). AAR is the repeated thinking about the possible causes and consequences of the negative events (i.e., a"why"focus) experience of peer victimization. CER is the individual's repeated thinking about the process, situation and details of the negative events (i.e., a "what" focus). AAR induces an abstract processing style by contrast, CER induces a concrete processing style (Watkins, 2004). According to construal level theory, people have different levels of abstraction in their representations of events. A high level of abstraction means a high-level construal, and a low level of abstraction means a low-level construal (Trope and Liberman, 2003; Zhang et al., 2018). People with high-level construals pay more attention to the essence of the event, tend to view things from a macro and long-term perspective, and think about the overall situation, which is conducive to individual self-control. People with low-level construals focus on the details of the event and tend to see things from a micro and short-term perspective for the sake of immediate interests, which leads to a failure of self-control (Chen, 2016). Several studies have shown that high-level construals promote self-control and thus make individuals focus more on the long-term benefits of events rather than the immediate concrete outcomes; these individuals thus exhibit more self-control behaviors (Huang et al., 2015; Zhang et al., 2018). The research results of the adolescent group suggest that the construal level is significantly positively correlated with the control system of self-control and is significantly negatively correlated with the impulse system of

self-control (Wu et al., 2022). Given the above findings, adolescents who encounter peer victimization and individuals with an AAR tendency may have lower levels of revenge than those with a CER tendency.

Studies in psychotherapy find that after a negative event, writing down one's feelings, exploring the possible causes of the event, and analyzing the influence of the event can promote the process of psychological recovery and that AAR is similar to this process (Guo and Wu, 2011a,b). Chinese culture also involves idioms that are similar to AAR, such as "Every day I do self-inspection on three aspects." Reflection and review are regarded as activities that promote self-growth in Chinese culture. Therefore, AAR has the potential to promote the cognitive and social adaptation of individuals. AAR is likely to enable adolescents to recognize their own shortcomings and areas for improvement in peer victimization as well as the possible serious consequences of revenge, which in turn leads to multiple interpretations of the provocateur's intentions. Therefore, the level of HAB may be lower in individuals with AAR than in those with CER.

1.4 The present study

It is important to note that the rumination process in daily life is uncontrollable and involuntary. However, most existing studies on rumination are based on experimental studies of the rumination-induction paradigm. This may make the ecological validity of the rumination operation in the experimental study insufficient. Moreover, existing research has mostly used trait rumination questionnaires and the respondents have mostly been college students; youth groups have rarely been involved. This study used the Adolescent Peer Victimization Rumination Questionnaire to investigate the role of rumination tendency between peer victimization and adolescent revenge. Based on social information processing theory (Crick and Dodge, 1994) and construal level theory (Trope and Liberman, 2003), the present study regards hostile attribution bias as the mediating factor in the relationship between peer victimization and revenge and further explores the moderating role of rumination tendencies on this process. The hypothesis model is shown in Figure 1.

According to the previous research, First, we expected that higher levels of peer victimization would report higher levels of revenge behaviors (Hypothesis 1). Second, we hypothesized that Hostile attribution bias would mediate the relationship between peer victimization and adolescent revenge (Hypothesis 2). Third, we hypothesized that Rumination tendency would moderate the relationship between peer victimization and adolescent revenge. Specifically, compared with individuals with an AAR tendency, peer victimization would have a larger role on adolescent revenge for those with a CER tendency (Hypothesis 3). Finally, we hypothesized that rumination tendency would moderate the relationship between peer victimization and hostile attribution bias. Specifically, compared with individuals with an AAR tendency, peer victimization would have a larger role on hostile attribution bias for those with a CER tendency (Hypothesis 4).

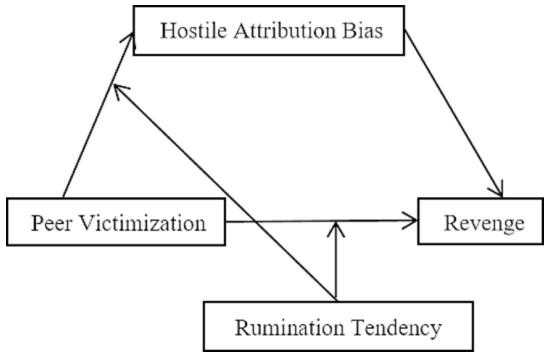

FIGURE 1
The proposed moderated mediation model.

2 Materials and methods

2.1 Participants and procedure

The sample for this study was drawn from October to December 2022, during the COVID-19 outbreak, when students began to attend online classes at home. The survey research complied with the relevant normative requirements of the Research Ethics Committee of Ludong University. Online questionnaires were used to obtain data. The link to the online questionnaire was delivered to participants via classroom instructors, and participants completed it independently. The purpose of the survey was explained to the participants on the first page of the questionnaire, and the respondents were ensured that personal information would be kept strictly confidential. This study got informed consent from the participants and their fathers or mothers, and the participants volunteered to participate anonymously.

This study used cluster sampling to select 35 junior high schools and 8 senior high schools from five provinces: Liaoning, Inner Mongolia, Jilin, Guizhou and Sichuan. A total of 18,914 students participated in the survey. We excluded invalid questionnaires based on the following criteria: an excessively short completion time, errors in the answer to the attention point monitoring item, and an answer of less than 7 points out of a possible 10 on a self-rated seriousness question. Referring to the screening method of existing studies (Zhang et al., 2009; Guo et al., 2017), students with a score of 1 (never) on each factor of peer victimization were categorized as "non-victims," those with a score of more than 1 but less than 3 (sometimes) were categorized as "seldom victims," and those with a score of 3 or more were categorized as "frequent victims." Among the valid samples, a total of 6,622 students have experienced peer victimization (including "seldom victims" and "frequently victims"), which is 5,198 junior high school students (grades 7–9) and 1,424 senior high school students (grades 10–12). 3,098 (46.78%) were boys and 3,524 (53.22%) were girls, with an age range for junior high school students of 13–16 years and an age range for senior high school students of 16–18 years.

2.2 Measures

2.2.1 Multidimensional peer victimization scale

The revised version of the Multidimensional Peer Victimization Scale (Guo et al., 2017) was used to measure participants' experiences of peer victimization. It contains four dimensions: physical victimization (3 items), verbal victimization (5 items), relational

victimization (7 items) and property victimization (3 items). Participants used a 4-point Likert scale (1 = never happened to 4 = often happened). Cronbach's alpha was 0.92 in this study. Confirmatory factor analysis showed that the construct validity of the scale was good (GFI = 0.94, CFI = 0.94, AGFI =0.92, RMSEA = 0.063).

2.2.2 Revenge scale

The revenge subscale of the Revised Transgression-Related Interpersonal Motivations Inventory (Chen et al., 2006) was used. Participants were required to evaluate their revenge level on 5 items (e.g.,"I will make him/her pay.") using a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The Chinese version of this subscale showed good applicability. Cronbach's alpha was 0.90 in this study. Confirmatory factor analysis showed that the construct validity of the scale was good (GFI = 0.99, CFI = 0.99, AGFI = 0.98, RMSEA = 0.056).

2.2.3 Word sentence association paradigm-hostility

The revised version of the Word Sentence Association Paradigm-Hostility (Zhang, 2019) was used to measure participants' hostile attribution bias. It contains 11 am biguous circumstances, and each circumstances is followed by a word related to hostility (e.g., "your friend did not respond to what you said: ignored"). Participants used a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The questionnaire had good internal consistency, test–retest reliability and validity. Cronbach's alpha was 0.95 in this study. Confirmatory factor analysis showed that the construct validity of the scale was good (GFI = 0.96, CFI = 0.98, AGFI =0.93, RMSEA = 0.075).

2.2.4 Peer victimization rumination questionnaire

We measured the rumination tendency of adolescents after peer victimization with self-administered Peer Aggression Rumination Questionnaire. The 13-item questionnaire includes two dimensions: abstract analytic rumination (AAR,7 items, e.g., "I think over and over again, trying to find out why he/she (they) hurt me") and concrete experiential rumination (CER, 6 items, e.g., "I cannot help thinking back to the details of my being bullied"). Responses are rated on a 5-point Likert scale (1 = never to 5 = always). Referring to the calculation method of Simple Coping Style Questionnaire (Dai, 2015), Rumination tendency = Z-score of CER - Z-score of AAR. Rumination tendency value greater than 0 suggests that the participant primarily uses CER. Rumination tendency value less than 0 suggests that participant mainly used AAR. Cronbach's alpha was 0.92 in this study. Confirmatory factor analysis showed that the construct validity of the scale was good (GFI = 0.96, CFI = 0.98, AGFI = 0.95, RMSEA = 0.060).

2.3 Data analysis

The effective data collected were analyzed by SPSS 26.0 software. Firstly, the Harman univariate test was used to test the existence of common method bias. Descriptive statistics and correlation analysis were conducted for the 4 variables to determine the relationship between the variables. In addition, collinearity diagnosis was performed to confirm the existence of multiple collinearities among variables. Secondly, model 8 in PROCESS version 3.5 of SPSS 26.0 macro program was used to test the moderating effect of rumination tendency.

3 Results

3.1 Common method bias test, multicollinearity diagnosis and correlation analyses of variables

On the one hand, by using an anonymous measuring approach, the common method deviation was reduced. The common method deviation, on the other hand, was regulated from the standpoint of statistical control following data collection by examining the exploratory factor analysis results. We used Harman single factor test to examine common method deviation. The results showed that KMO and Bartlett Test of Sphericity results was 0.966 ($p < 0.001$), indicating that it was suitable for the factor analysis. There were 6 factors with eigenvalues greater than 1, and the explained variance of the first factor was 32.21% (less than 40%; Deng et al., 2018), suggesting that common method deviation was not a serious threat in this study.

Furthermore, the variance inflation factor (VIF) was used to establish the occurrence of multicollinearity amongst variables (Yang et al., 2012). The findings reveal that the VIF values ranged from 1.30 to 1.81, significantly less than the critical value of 10, while tolerance values ranged from 0.55 to 0.72, which were greater than 0.1 (Zhao et al., 2023) Therefore, there was no multicollinearity problem in the mode.

According to the pearson correlation analysis, the primary variables were significantly correlated with each other (see Table 1). Specifically, pairwise significant positive correlations were found between peer victimization, revenge, hostility attribution bias and rumination tendency. The demographic variables of gender, grade, school location, boarding situation, and left-behind status were significantly correlated with the main variables, and they were included in the model as control variables in the subsequent moderated mediation analysis.

3.2 Moderated mediation analysis

Every variable was standardized. Model 4 of the PROCESS macro was applied to assess the mediation effect of hostile attribution bias. Gender, grade, school location, boarding and left-behind status were

TABLE 1 Descriptive statistics and correlations among all variables.

Variables	*M*	*SD*	1	2	3	4
1. Peer victimization	1.56	0.53	1			
2. Revenge	2.77	1.02	0.44**	1		
3. Hostile attribution bias	2.10	1.00	0.53**	0.57**	1	
4. Rumination tendency	–	–	0.30**	0.52**	0.55**	1
5. Gender	–	–	0.04**	0.03*	0.02	0.01
6. Grade	–	–	0.05**	0.11**	0.09**	0.02
7. School location	–	–	−0.04**	0.02	0	0
8. Boarding	–	–	−0.01	−0.03*	−0.02	0.01
9.Left behind status	–	–	−0.02*	−0.02	−0.03*	0

*$p < 0.05$, **$p < 0.01$.

control variables. Peer victimization significantly positively predicted revenge ($\beta = 0.45$, $p < 0.001$). Peer victimization significantly positively predicted hostile attribution bias ($\beta = 0.53$, $p < 0.001$). After incorporating hostile attribution bias into the regression equation, hostile attribution bias significantly positively predicts revenge. Peer victimization can still significantly positively predict revenge ($\beta = 0.20$, $p < 0.001$). Bootstrap analysis indicated that the direct effect of peer victimization on revenge was significant [effect size = 0.20, Boot SE = 0.01; 95% CI = (0.18, 0.22)], and the mediating effect of hostile attribution bias was significant [effect size = 0.24, Boot SE = 0.01; 95% CI = (0.23, 0.26)]. Therefore peer victimization can not only directly predict revenge but can also predict revenge through the mediating role of hostile attribution bias. The direct effect and mediating effect accounted for 45.45 and 54.55% of the total effect, respectively.

Furthermore, we examined the moderating effect of rumination tendency using Model 8 of the PROCESS macro. The results showed that (see Table 2) the interaction between peer victimization and rumination tendency significantly predicted hostile attribution bias [$\beta = 0.14$, $p < 0.001$, 95% bootstrap CI (0.13, 0.16)], and also significantly predicted revenge [$\beta = 0.12$, $p < 0.001$, 95% bootstrap CI (0.11, 0.13)]. Therefore, we came to the conclusion that rumination tendencies significantly moderated both the intermediary first half path and the direct path. In order to more intuitively illustrate the moderating effect of rumination tendency, the study defined the mean of the rumination tendency variable score, plus one standard deviation of the data as CER support data, and the sample mean minus one standard deviation of the data as AAR support data. As a result, a simple slope effect diagram with different degrees of rumination tendency was displayed in Figures 2, 3. Figure 2 shows that for participants who tended to engage in CER, peer victimization significantly predicted revenge, simple slope = 0.30, $t = 24.31$, $p < 0.05$. For participants who tended to engage in AAR, peer victimization had no significant effect on revenge, simple slope = 0.01, $t = 0.48$, $p > 0.05$. This finding demonstrated that the higher the individual's proclivity toward CER, the greater the positive predictive effect of peer victimization on revenge. Figure 3 shows that for participants who tended toward CER, peer victimization had a significant positive predictive effect on hostile attribution bias, simple slope = 0.49, $t = 49.32$, $p < 0.001$; for participants who tended toward AAR, although peer victimization also had a positive predictive effect on HAB, its predictive effect was weaker, simple slope = 0.14, $t = 9.85$, $p < 0.001$. This finding indicated that the individuals tended toward CER, the higher the predictive effect of peer victimization on hostile attribution bias. Furthermore, at the three levels of rumination tendency, as the rumination tendency changes from AAR to CER, peer victimization is more likely to induce revenge by increasing hostile attribution bias.

4 Discussion

This study explored the relationship and internal mechanism of peer victimization on adolescents' revenge. We analyzed the mediating role of hostility attribution bias and the moderating role of rumination tendency. This study found that peer victimization significantly positively predicted revenge. The stronger the degree of peer victimization, the higher the possibility of revenge among adolescents, which supported research Hypothesis 1. The result aligned with social information processing theory (Crick and Dodge, 1994). That is,

TABLE 2 The moderated mediation model.

Regression equation		Overall fit index			Significance of regression coefficient			
outcome	Predictors	R	R^2	F	β	LLCI	ULCI	t
HAB	Gender	0.70	0.50	812.06***	0.01	−0.03	0.04	0.49
	Grade				0.05	0.03	0.06	7.27***
	School Location				0.01	−0.03	0.05	0.33
	Boarding				0.02	−0.03	0.07	0.86
	Left behind				−0.02	−0.06	0.02	−0.96
	PV				0.31	0.29	0.33	31.85***
	RT				0.32	0.31	0.34	42.07***
	PV × RT				0.14	0.13	0.16	24.11***
Revenge	Gender	0.67	0.45	589.60***	0.03	−0.01	0.07	1.57
	Grade				0.05	0.04	0.06	7.31***
	School Location				0.04	−0.01	0.08	1.67
	Boarding				0.01	−0.04	0.06	0.44
	Left behind				0.01	−0.03	0.04	0.25
	PV				0.15	0.13	0.17	13.62***
	HAB				0.23	0.20	0.25	17.63***
	RT				0.25	0.23	0.27	27.26***
	PV × RT				0.12	0.11	0.13	18.20***

All variables in the model were standardized and brought into the regression equation.
PV, Peer Victimization; HAB, Hostile Attribution Bias; RT, Rumination Tendency.
*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

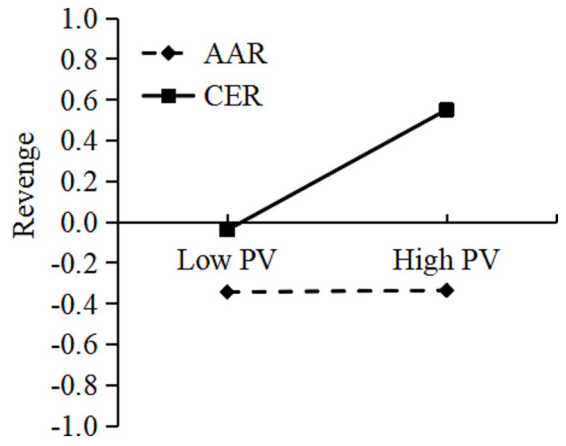

FIGURE 2
Rumination tendency as a moderator in the relationship between peer victimization and revenge. Low pv, Low Peer Victimization; High pv, High Peer Victimization.

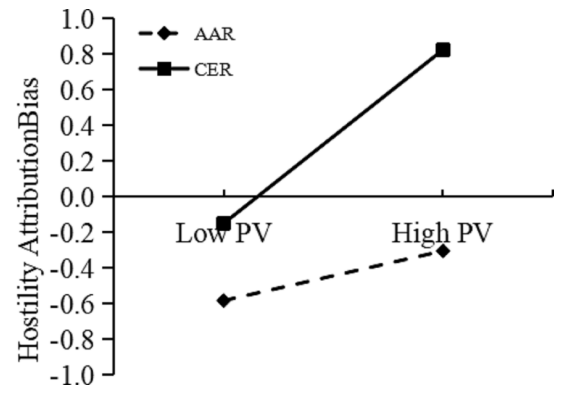

FIGURE 3
Rumination tendency as a moderator in the relationship between peer victimization and hostile attribution bias. Low pv, Low Peer Victimization; High pv, High Peer Victimization.

people encode social cues and deduce others' behavioral intentions based on previous experience, beliefs, and situations, which affect the response to current events and lead to subsequent behavior.

Consistent with the conclusions of previous studies, frequent peer victimization aggravates individuals' subjective perception of peer hostility. Individuals can quickly identify the hostile behavior intentions of peers due to their previous experience of being abused; thus, more aggressive behaviors are used to cope with conflicts (Xiao et al., 2023). At the same time, this may amplify the hostility of individual subjective perceptions of peer behavior intentions (Schacter and Juvonen, 2015). Adolescents may believe that their peers are deliberately targeting them, prompting them to take more revenge to resolve peer conflicts. This makes them change from the "victim" to the "perpetrator."

This study found that hostile attribution bias played a mediating role between peer victimization and adolescent revenge, which supported research Hypothesis 2. The conclusion of this study supports the social information processing model (Crick and Dodge, 1994). Individuals' social experiences affect their cognition and play a role in behavioral responses in later social interactions. The conclusions of the study verify the research inference of Graham and Juvonen (1998) that hostile attribution bias is related to the revenge behavior of middle school students, which may be derived from previous experiences of being hurt by peers. As suggested by the results of several existing experimental studies, hostile attribution bias not only leads to aggression but also maintains aggressive behavior patterns (Verhoef et al., 2019). Actual peer victimization activates a hostile cognitive bias, which in turn predicts subsequent aggressive responses (DeWall et al., 2009; Reijntjes et al., 2011). That is, peer victimization changes the way youth attend to social cues, by increasing their hypervigilance to hostile cues (Reijntjes et al., 2011). This helps us to better understand the recurrence and vicious cycle of revenge. In summary, peer victimization is an important risk factor that affects individual cognitive development, which makes adolescents tend to have negative views of interpersonal events. Adolescents' attributional bias toward an aggressor's behavioral intentions is a powerful predictor of whether the adolescent will attempt revenge. Therefore, It is of great practical significance to explore the influence of peer victimization on revenge from the perspective of adolescent cognition to prevent the revenge of adolescents who suffered from peer victimization.

The present study found that the effects of peer victimization on adolescents' hostile attribution bias and revenge were moderated by rumination tendencies. First, rumination tendency moderated the direct path of peer victimization on revenge, supporting research Hypothesis 3. The positive predictive effect of peer victimization on revenge was stronger for adolescents who tended toward CER than for those who tended toward AAR. Consistent with past research that rumination play an essential role in which victimization and life stress forecasts externalizing issues such as bullying perpetration (Malamut and Salmivalli, 2021) and delinquent and aggressive conduct (LeMoult et al., 2019). Second, rumination tendency moderated the predictive effect of peer victimization on hostile attribution bias, supporting research Hypothesis 4. Peer victimization had a stronger positive predictive effect on hostile attribution bias for individuals who tended toward CER than for adolescents who tended toward AAR. This supports the findings of Pedersen et al. (2011) that provocation-focused rumination (i.e., dwelling on a specifc grievance or occurrence) predicted aggressive cognition. However our conclusions are contrary to the findings of studies on depression rumination. Research on depression rumination suggests that CER contributes to problem solving compared to AAR (Watkins and Moulds, 2005). AAR can cause individuals to maintain or enhance anger (Denson et al., 2012), produce negative overgeneralizations (Watkins, 2008). We found that CER and AAR, in existing studies, focus on negative emotions (e.g., depression or angry) or the self (e.g., why am I always anxious), but AAR may be more conducive to individual to coping negative events objectively and rationally when the content of the rumination focused on a specific event experienced rather than on negative emotions or the self in the context of Chinese culture. The theoretical model of triggered displaced aggression (Miller et al., 2003) provides some explanation for the link between rumination tendencies and revenge. This theory suggests that infringement elicits negative emotions in the victim, which in turn activates related cognitive and motivational structural nodes within the same associative network. The association of these nodes makes adolescents perceive and respond to interpersonal harm and forms memory imprints in a network of associations. Thus, the more individuals tend to engage in CER, the more they repeatedly experience

emotional feelings when they are hurt, maintaining the infringement network that is activated by the initial provocation. Furthermore, the cognitive (hostile attribution bias) and motivational (revenge motivation) nodes associated with the peer victimization event may be reactivated (Zhang et al., 2015; Ruddle et al., 2017). In contrast, adolescents who tend toward AAR conduct an in-depth rational analysis of the possible causes of peer victimization and the possible consequences of revenge, and they have multiple interpretations of their peers' intentions. This helps the victim recall the experience of being bullied with calm cognition and examine peer victimization events without reactivating negative emotions. Supported by the research of Ding and Qian (2020), individuals who tend toward AAR can better deal with stimulating events and view problems more objectively and rationally. Current research extends past research to prove that rumination tendencies play a moderating role between peer victimization and revenge. We attempted to categorize negative experience rumination from the perspective of cognitive processing mode. The results of the study found that in the context of Chinese culture, which advocates introspection, AAR may play a constructive role in responsing negative events compared with CER.

5 Contribution and implications

In the literature on peer victimization, the victim's retaliation has always been a neglected area. Although studies have confirmed the strong association between peer victimization and revenge, the mechanisms by which peer victimization affects revenge are unclear. A review of existing research indicates that most current studies use the concept of general aggression. Few studies have distinguished between subtypes of proactive and reactive aggression. Revenge, as a sub-type of reactive aggression, is a delayed reactive aggression, unlike immediate reactive aggression. As many SIP models suggest, in-the-moment behaviors are often not carefully considered, but are more automatic and reflexive. Reflexive socialcognitive processes are automatic, fast, and unconscious whereas reflective social-cognitive processes are relatively conscious and more deliberate (Evers et al., 2014). Some Avengers will wait months or even years to carry out their revenge. What happens in people's minds when they make these decisions? People's appraisal of a transgression is a strong predictor of whether they will take revenge (Jackson et al., 2019). Mind perception is a key factor in these appraisals (Young et al., 2011). However, few studies have explored the cognitive mechanisms of revenge. The present study concentrated on the above issues and explored the relationships among peer victimization, hostile attribution bias, rumination tendencies and revenge from a cognitive perspective. It enriched the research category of reactive aggression. It also provided empirical support for scientific prevention of revenge. In addition, we demonstrated the moderating role of rumination tendency and made new findings on the effects of abstract analytic rumination. The current study, to our knowledge, is the first to classify the victimized experience rumination based on a cognitive processing model, and then to explore the moderating role of peer victimization rumination tendencies on revenge and hostile attribution bias. Our findings emphasize the need to dialectically view the role of different rumination tendencies in different cultural contexts. Rumination does not always lead to same outcomes, and interventions for maladaptive coping strategies in adolescents after peer victimization should primarily target concrete experiential rumination (CER) rather than abstract analytical rumination (AAR).

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found in the article/supplementary material.

Ethics statement

The studies involving human participants were reviewed and approved by Ludong University Ethics Committee. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

X-YZ: Conceptualization, Investigation, Software, Writing – original draft, Writing – review & editing. S-JZ: Conceptualization, Data curation, Methodology, Writing – review & editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

Chang, E. C., Tsai, W., and Sanna, L. J. (2010). Examining the relations between rumination and adjustment: do ethnic differences exist between Asian and European Americans? *Asian Am. J. Psychol.* 1, 46–56. doi: 10.1037/a0018821

Chawla, N., and Ostafin, B. (2007). Experiential avoidance as a functional dimensional approach to psychopathology: an empirical review. *J. Clin. Psychol.* 63, 871–890. doi: 10.1002/jclp.20400

Chen, W. (2016). *The impact of Mobile phone use on adolescent self-control: A construal-level approach*. Wuhan: Huazhong Normal University.

Chen, X. (2019). A study on the relationship between peer aggression and problem behaviors among urban and rural primary and middle school students in QinBa mountainous area. *Soc. Welfare* 6, 58–63.

Chen, Y., Zhang, W., Zhu, J., Yu, C., Zhang, Y., and Lu, Z. (2016). Peer victimization and problematic online game use among adolescents: a moderated mediation model. *Psychol. Dev. Educ.* 32, 733–744. doi: 10.16187/j.cnki.issn1001-4918.2016. 06.12

Chen, Z., Zhu, N., and Liu, H. (2006). Psychometric features of Wade forgiveness scale and transgression-related interpersonal motivation Scale-12-item form in Chinese college students Wade. *Chin. Ment. Health J.* 20, 617–620. doi: 10.3321/ j.issn:1000-6729. 2006.09.021

Choi, J. H. S., and Miyamoto, Y. (2023). Cultural differences in rumination and psychological correlates: the role of attribution. *Personal. Soc. Psychol. Bull.* 49, 1213–1230. doi: 10.1177/01461672221089061

Crick, N. R., and Dodge, K. A. (1994). A review and reformulation of social information-processing mechanisms in Children's social adjustment. *Psychol. Bull.* 115, 74–101. doi: 10.1037/0033-2909.115.1.74

Crick, N. R., and Dodge, K. A. (1996). Social information-processing mechanisms in reactive and proactive aggression. *Child Dev.* 67, 993–1002. doi: 10.1111/j.1467-8624.1996. tb01778.x

Dai, X. (2015). *Manual of commonly used psychological assessment scales*. Beijing: People's Military Medical Publishing House.

Deng, W. G., Li, X. Y., Chen, B., Luo, K., and Zeng, X.-Y. (2018). Analysis on application of common methods Bias test to psychological studies during recent five years in China. *J. Jiangxi Norm. Univ. Nat. Sci.* 42, 447–453. doi: 10.16357/j.cnki. issn1000-5862.2018.05.02

Denson, T. F. (2013). The multiple systems model of angry rumination. *Personal. Soc. Psychol. Rev.* 17, 103–123. doi: 10.1177/1088868312467086

Denson, T. F., Moulds, M. L., and Grisham, J. R. (2012). The effects of analytical rumination, reappraisal, and distraction on anger experience. *Behav. Ther.* 43, 355–364. doi: 10.1016/j.beth.2011.08.001

DeWall, C. N., Twenge, J. M., Gitter, S. A., and Baumeister, R. F. (2009). It's the thought that counts: the role of hostile cognition in shaping aggressive responses to social exclusion. *J. Pers. Soc. Psychol.* 96, 45–59. doi: 10.1037/a0013196

Ding, X., and Qian, M. (2020). The regulation effects of anger rumination on different foci of anger. *J. Appl. Soc. Psychol.* 50, 368–377. doi: 10.1111/jasp.12666

Dodge, K. A. (2006). Translational science in action: hostile attributional style and the development of aggressive behavior problems. *Dev. Psychopathol.* 18, 791–814. doi: 10.1017/s0954579406060391

Evers, C., Hopp, H., Gross, J. J., Fischer, A. H., Manstead, A. S., and Mauss, I. B. (2014). Emotion response coherence: a dual-process perspective. *Biol. Psychol.* 98, 43–49. doi: 10.1016/j.biopsycho.2013.11.003

Fitness, J. (2001). *Betrayal, rejection, revenge, and forgiveness: An interpersonal script approach*. New York: Oxford University Press

Graham, S., and Juvonen, J. (1998). Self-blame and peer victimization in middle school: an attributional analysis. *Dev. Psychol.* 34, 587–599. doi: 10.1037//0012-1649.34.3.587

Guo, H., Chen, L., Ye, Z., Pan, J., and Lin, D. (2017). Characteristics of peer victimization and the bidirectional relationship between peer victimization and internalizing problems among rural-to-urban migrant children in China: a longitudinal study. *Acta Psychol. Sin.* 49, 336–348. doi: 10.3724/SP.J.1041.2017.00336

Guo, S., and Wu, X. (2011a). Rumination and mental health (review). *Chin. Ment. Health J.* 25:314–.318. doi: 10.3969/j.issn.1000-6729.2011.04.018

Guo, S., and Wu, X. (2011b). Rumination: theories, mechanism and scales. *Chin. J. Spec. Educ.* 3, 89–93.

Huang, J., Li, Y., and Zhang, H. (2015). The application and development of construal level theory. *Adv. Psychol. Sci.* 23, 110–119. doi: 10.3724/SP.J.1042.2015.00110

Jackson, J. C., Choi, V. K., and Gelfand, M. J. (2019). Revenge: a multilevel review and synthesis. *Annu. Rev. Psychol.* 70, 319–345. doi: 10.1146/annurev-psych-010418-103305

Kwon, H., Yoon, K. L., Joormann, J., and Kwon, J. (2013). Cultural and gender differences in emotion regulation: relation to depression. *Cognit. Emot.* 27, 769–782. doi: 10.1080/02699931.2013.792244

LeMoult, J., Humphreys, K. L., King, L. S., Colich, N. L., Price, A. N., Ordaz, S. J., et al. (2019). Associations among early life stress, rumination, symptoms of psychopathology, and sex in youth in the early stages of puberty: a moderated mediation analysis. *J. Abnorm. Child Psychol.* 47, 199–207. doi: 10.1007/s10802-018-0430-x

Li, X., Chen, L., Pan, B., and Zhang, W. (2021). A cross-lagged analysis of associations between peer victimization and hostile attribution Bias. The 23rd National Psychology Academic Conference. Hohhot, Inner Mongolia, China.

Li, E., and Feng, S. (2010). Theoretical models and related factors of vengeance. *Adv. Psychol. Sci.* 18, 1644–1652.

Luo, F., Wang, X., Zhang, S., and Shen, D. (2010). Characteristics of cognitive emotion regulation strategies in adolescents. *Chinese Jouranl of. Clin. Psychol.* 18:93-96, 90. doi: 10.16128/j.cnki.1005-3611.2010.01.022

Mynard, H., and Joseph, S. (2000). Development of the multidimensional peer-victimization scale. *Aggress. Behav.* 26, 169–178. doi: 10.1002/(sici)1098-2337(2000) 26:2<169::aid-ab3>3.0.co;2-a

Malamut, S. T., and Salmivalli, C. (2021). Rumination as a mediator of the prospective association between victimization and bullying. *Res. Child Adolesc. Psychopathol.* 49, 339–350. doi: 10.1007/s10802-020-00755-z

McCullough, M. E. (2017). *Beyond Reveng: The evolution of the forgiveness instinct*. Beijing: People's Publishing House.

Miller, N., Pedersen, W. C., Earleywine, M., and Pollock, V. E. (2003). Artificial a theoretical model of triggered displaced aggression. *Personal. Soc. Psychol. Rev.* 7, 57–97. doi: 10.1207/s15327957pspr0701_5

Pedersen, W. C., Denson, T. F., Goss, R. J., Vasquez, E. A., Kelley, N. J., and Miller, N. (2011). The impact of rumination on aggressive thoughts, feelings, arousal, and behaviour. *Br. J. Soc. Psychol.* 50, 281–301. doi: 10.1348/014466610X515696

Reijntjes, A., Thomaes, S., Kamphuis, J. H., Bushman, B. J., de Castro, B. O., and Telch, M. J. (2011). Explaining the paradoxical rejection-aggression link: the mediating effects of hostile intent attributions, anger, and decreases in state self-esteem on peer rejection-induced aggression in youth. *Personal. Soc. Psychol. Bull.* 37, 955–963. doi: 10.1177/0146167211410247

Rowell Huesmann, L. (1988). An information processing model for the development of aggression. *Aggress. Behav.* 14, 13–24. doi: 10.1002/1098-2337(1988)14:1<13::AID-AB2480140104>3.0.CO;2-J

Ruddle, A., Pina, A., and Vasquez, E. (2017). Domestic violence offending behaviors: a review of the literature examining childhood exposure, implicit theories, trait aggression and anger rumination as predictive factors. *Aggress. Violent Behav.* 34, 154–165. doi: 10.1016/j.avb.2017.01.016

Schacter, H. L., and Juvonen, J. (2015). The effects of school-level victimization on self-blame: evidence for contextualized social cognitions. *Dev. Psychol.* 51, 841–847. doi: 10.1037/dev0000016

Smalley, D., and Banerjee, R. (2014). The role of social goals in Bullies' and Victims' social information processing in response to ambiguous and overtly hostile provocation. *Soc. Dev.* 23, 593–610. doi: 10.1111/sode.12067

Trope, Y., and Liberman, N. (2003). Temporal Construal. *Psychol. Rev.* 110, 403–421. doi: 10.1037/0033-295X.110.3.403

Verhoef, R., Alsem, S. C., Verhulp, E. E., and De Castro, B. O. (2019). Hostile intent attribution and aggressive behavior in children revisited: a Meta-analysis. *Child Dev.* 90, e525–e547. doi: 10.1111/cdev.13255

Walters, G. D. (2020). Mediating the victim-offender overlap with delinquent peer associations: a preliminary test of the person proximity hypothesis. *Crim. Justice Stud.* 33, 297–315. doi: 10.1080/1478601x.2020.1711752

Wang, J., Yu, C., Zhen, S., and Zeng, S. (2020). Peer victimization and adolescent aggressive behavior: a moderated mediation model. *J. Beijing Normal Univ.* 4, 60–69.

Watkins, E. (2004). Adaptive and maladaptive ruminative self-focus during emotional processing. *Behav. Res. Ther.* 42, 1037–1052. doi: 10.1016/j.brat.2004.01.009

Watkins, E. R. (2008). Constructive and unconstructive repetitive thought. *Psychol. Bull.* 134, 163–206. doi: 10.1037/0033-2909.134.2.163

Watkins, E., and Moulds, M. (2005). Distinct modes of ruminative self-focus: impact of abstract versus concrete rumination on problem solving in depression. *Emotion* 5, 319–328. doi: 10.1037/1528-3542.5.3.319

Wu, Y., Ding, N., Chen, P., Li, Z., Huang, X., et al. (2022). The effect of construal level on self-control and the neuro-electrophysiological characteristics: based on a dual-systems model. The 24th National Psychology Academic Conference, Xinxiang, Henan, China.

Xiang, Y., He, N., and Zhao, J. (2022). Social support and moral sensitivity: the mediating role of moral identity. *J. Psychol. Sci.* 45, 111–117. doi: 10.16719/j. cnki.1671-6981.20220116

Xiao, J., Shen, Z., Li, X., and Lin, D. (2023). Peer victimization trajectories and their relationships with depressive symptoms and externalizing problems: risk enhancement or risk susceptibility. *Acta Psychol. Sin.* 55, 978–993. doi: 10.3724/ SP.J.1041.2023.00978

Xu, X. (2014). A review on the cognitive emotion regulation strategies. *J. Jiangxi Norm. Univ.* 40, 148–153. doi: 10.16095/j.cnki.cn32-1833/c.2014.01.020

Yang, M., Xiao, J., and Cai, H. (2012). Multicollinearity in multivariate analysis and its processing methods. *Chin. J. Health Stat.* 29, 620–624.

Yao, Z., and Enright, R. (2021). Developmental cascades of hostile attribution Bias, aggressive behavior, and peer victimization in preadolescence. *J. Aggress. Maltreat. Trauma* 31, 102–120. doi: 10.1080/10926771.2021.1960455

Ye, S., Zhang, X., and Liu, Y. (2018). The influence of peer bullying on junior high school students' aggression: a moderated mediation model. *Educat. Measure. Eval.* 7, 57–64. doi: 10.16518/j.cnki.emae.2018.07.010

Young, L., Scholz, J., and Saxe, R. (2011). Neural evidence for "intuitive prosecution": the use of mental state information for negative moral verdicts. *Soc. Neurosci.* 6, 302–315. doi: 10.1080/17470919.2010.529712

Zhang, Q. (2019). *Interpersonal openness and reactive aggression among junior high school students: The mediating role of hostile attribution bias. Master thesis.* Chongqing: Southwest University.

Zhang, X. (2020). *Anticipation and cognitive strategy affect the processing of emotional pictures: Behavioral and ERP evidence. Master thesis*. Chongqing: Southwest University.

Zhang, W., Chen, L., Ji, L., Zhang, L., Zhang, G., and Wang, S. (2009). Physical and relational victimization and Childrens emotional adjustment in middle childhood. *Acta Psychol. Sin.* 41, 433–443. doi: 10.3724/SP.J.1041.2009.00433

Zhang, Y., Dou, D., and Xin, Z. (2018). The effect of construal levels on self-control. *Adv. Psychol. Sci.* 26, 1878–1889. doi: 10.3724/SP.J.1042.2018.01878

Zhang, S., Tang, H., Liu, Y., and Lv, S. (2015). Transgression sensitivity and interpersonal forgiveness: mediating of anger rumination. *Chin. J. Clin. Psych.* 23, 706–708. doi: 10.16128/j.cnki.1005-3611.2015.04.031

Zhao, K., Chen, N., Liu, G., Lun, Z., and Wang, X. (2023). School climate and left-behind children's achievement motivation: the mediating role of learning adaptability and the moderating role of teacher support. *Front. Psychol.* 14:1040214. doi: 10.3389/fpsyg.2023.1040214

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TYPE Registered Report
PUBLISHED 09 December 2024
DOI 10.3389/fpsyt.2024.1189777

Check for updates

OPEN ACCESS

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RECEIVED 20 March 2023
ACCEPTED 21 November 2024
PUBLISHED 09 December 2024

CITATION
Onda K, Ichwansyah R, Kawasaki K, Egawa J, Someya T and Hasegawa I (2024) Spontaneous theory of mind in autism: are anticipatory gaze and reaction time biases consistent?. *Front. Psychiatry* 15:1189777. doi: 10.3389/fpsyt.2024.1189777

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Spontaneous theory of mind in autism: are anticipatory gaze and reaction time biases consistent?

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Background: Individuals with autism spectrum disorder (ASD) exhibit persistent deficits in social interaction and communication in adulthood. Pioneering studies have suggested that these difficulties arise from a lack of immediate, spontaneous mentalizing (i.e., theory of mind: ToM), specifically, an ability to attribute false beliefs to others, which should be usually acquired during neurotypical development. However, this view has been challenged by recent reports of nonreplications of spontaneous mentalizing, even in neurotypical adults.

Objectives: We aimed to evaluate (1) whether measurements of spontaneous ToM in two representative paradigms, gaze bias in the anticipatory looking (AL) test and reaction time bias in the object detection (OD) test, are correlated in neurotypical adults and (2) whether these two measurements are altered in individuals with ASD.

Methods: We developed a novel hybridized spontaneous false belief test combining the AL and OD paradigms to enable within-subject comparison of different spontaneous ToM measurements.

Results: The results obtained with our hybridized test replicated the earlier positive evidence for spontaneous ToM in both AL and OD paradigms. Our results also revealed a correlation between the participants' spontaneous gaze bias in the AL paradigm and reaction time bias in the OD paradigm, indicating that the participants who had spontaneously anticipated other's false belief driven actions more quickly detected the object. We further found that spontaneous gaze and reaction time biases were altered in individuals with ASD. Finally, we ascertained those inclusions of these biases as diagnostic variables in a regression model improved the accuracy of diagnosing ASD. ASD diagnosis was best predicted by the model when variables obtained from both AL and OD methods were included in the model.

Conclusions/implications: Our hybridized paradigm not only replicated spontaneous gaze bias in early AL studies and reaction time bias in the OD paradigms, but indicated significant correlation between them, suggesting that

different implicit tasks tap the same spontaneous ToM in neurotypical adults. Group differences of these indices between ASD and neurotypical adult groups indicated that our task could help diagnose ASD, which is essential for evaluating the social difficulties that individuals with ASD face in adulthood.

KEYWORDS

autism, theory of mind, spontaneous mentalizing, false belief test, anticipatory gaze, reaction time

1 Introduction

Autism spectrum disorder (ASD), a neurodevelopmental disorder with social and communication deficits as the core symptoms (1), is best explained as impairments of theory of mind (ToM) (2). ToM is defined as the ability to attribute mental states, such as beliefs or motivations, to other individuals (3). The normal acquisition and impairments of ToM are conventionally evaluated with verbal false belief (FB) tasks, such as the Sally and Ann task (4), which examines the ability to report that others have beliefs that are different from one's own. The ages at which half of children pass these tasks are approximately 4 years and 9 years for children with neurotypical development and ASD, respectively; this difference is expected to discriminate between children with neurotypical development and those with ASD (5).

However, verbal (explicit) FB tasks might not be ideal for diagnosing ASD, as they require executive functions beyond ToM, such as linguistic ability and inhibitory control. Accumulating studies have emphasized that the ability to attribute FBs to others spontaneously and promptly is crucial for initiating and responding to social communication, as well as for building fluent social interactions. Explicit FB tasks may not effectively assess this ability. Even if adults with ASD pass explicit FB tests, they often continue to struggle with interpersonal communication and interactions, which are typically challenging for them (1, 6). Since the 2000s, Onishi and Baillargeon (7) Southgate et al. (8) and Kovács et al. (9) have analyzed the performance of young children who have not yet acquired language skills in nonverbal (implicit) ToM tasks. Implicit tasks measure spontaneity or promptness in FB attribution and should therefore be promising for the diagnosis of ASD. Senju et al. (10) analyzed the performance of adults in the anticipatory looking (AL) task, which is one of the major implicit tasks used to measure theory of mind implicitly by tracking spontaneous eye movement patterns while watching a FB task movie. They reported differences between those with neurotypical development and those with ASD, hypothesizing that "the absence of spontaneous theory of mind would cause difficulty in social interaction and communication, even in adults with high verbal and cognitive skills" (11).

Abbreviations: ASD, ToM, FB, AL, OD, VOE, and AQ.

However, many recent attempts to replicate earlier findings (12–19) using implicit FB tasks have failed, raising serious concerns about whether implicit tasks truly measure ToM. The disadvantages of these tasks include a very high dropout rate and difficulty in participant engagement following implicit task instructions (17). Most recent nonreplicated studies using the AL paradigm developed by Southgate et al. (8) reported high dropout rates of over 40% (12), and this method is difficult to replicate even in neurotypical adults and children (14, 15). Kulke and Hinrichs (20) attempted replication in adults by constructing a realistic interactive paradigm (realistic paradigm) with a storyline in the task movie, but there was no significant improvement in dropout rates or test results compared with those of the original study. In contrast, the object detection (OD) test (9), a test used to evaluate the degree of implicit FB attribution to others by measuring reaction time, is more engageable owing to the task achievement goal of button pressing. The irrelevance between the task instructions and the agent's belief is expected to reduce dropout rate and learning effects. Therefore, we thought that a combination of these two methods could provide a more reliable testing approach, as the OD requires a certain level of active participation. In addition, we developed several improvements to this task. In general, nonverbal (implicit) FB tasks are susceptible to context-specific variables in the experimental environment and the content of the movies (21), which may be one of the reasons why consistent results have not been obtained within and across tasks. In the present study, we took several steps to reduce the influence of external factors as much as possible. We used a minimally stimulating experimental booth and non-invasive head fixation to obtain eye-movement measurements, thereby directing attention to the monitor. The total duration of the experiment was shortened to approximately 20 minutes, given the limitations of participant concentration. The contents of the movies composed a storyline, and the viewpoint was from the agent's perspective, in accordance with the OD. To increase the sensitivity of the eye-movement measurement, a sufficient visual field range with a maximum visual field angle of 8° was secured. Furthermore, by combining the AL and OD paradigms, the task instructions were limited to the minimum necessary, such as "Please pull the lever on the side where the object reappeared at the end of the movie", which were irrelevant to the explicit comprehension of the agent's intension in the AL paradigm. In the present study, the task

movies were presented repeatedly; however, we prevented learning effects by interrupting the movie at the object detection scene instead of showing the last scene as in the AL paradigm (the scene in which the agent captures the object). No significant learning effect was present in the pilot or present study (Supplementary Figures 2, 6).

We developed a paradigm that measures AL eye movements during the OD task in adult participants to identify differences in spontaneous FB attribution abilities (i.e., ToM) between neurotypical adults and adults with ASD. We initially used this paradigm to examine our first research question: Is spontaneous ToM reproducible in neurotypical adults? Specifically, we tested whether there is a significant gaze bias indicating the implicit attribution of FBs to agents in movies among neurotypical adults (Hypothesis 1: H1). Since the reproducibility of the AL paradigm should depend on whether participants can anticipate the agent's behavior, the first step was to determine whether spontaneous gaze of neurotypical adults reliably anticipated the agent's behavior in the true belief (TB) condition in our paradigm. Once this prerequisite was established, we then asked whether anticipatory gaze behavior was confirmed under FB conditions. Reproducibility of the anticipatory gaze bias in the FB condition would support the claim of the existence of spontaneous ToM.

Next, while explicit ToM has been consistently observed across various tasks, no systematic correlations have been found between the different types of implicit tasks (22, 23). This leads to the second research question: Is there a concept of spontaneous ToM that is tapped into by different tasks? In other words, is gaze-based implicit ToM defined with the AL paradigm equivalent to reaction time-based spontaneous ToM defined with the OD? Our newly constructed FB task provides results for each paradigm simultaneously, allowing direct comparison of both paradigms. Using this task, we tested the following hypotheses that anticipatory gaze behavior and reaction-time bias on the object detection test are consistent within individuals and that anticipatory gaze behavior and reaction-time bias on the object detection test are correlated, with anticipatory gaze affecting reaction time (H2). The correlation of these two independent measures would support the existence of task-invariant spontaneous ToM.

The present study aims to resolve the long-standing controversy over whether the AL paradigm truly measures spontaneous ToM, which has been contentious for year. In the pilot study, the AL and OD results were significantly correlated (Supplementary Figure 4; the number of neurotypical adults participating in the study was increased to 20 for statistical evaluation following registration). Furthermore, if spontaneous ToM is reproducible across tasks among neurotypical adults, it will lead to a third research question: does spontaneous ToM differ between neurotypical adults and ASD adults (H3)? If ASD adults demonstrate impairments in spontaneous FB formation, then the proportion of correct first looks and the differential looking time score (DLTS) measured by the AL method and the ToM index value (see below) in the OD of ASD adults are expected to be significantly lower than those of neurotypical adults.

Finally, we examined the relationship between each measurements and the autism-spectrum quotient (AQ) score or ASD diagnosis. The pilot study indicated that the AQ score was correlated with the ToM index, suggesting that individuals with higher AQ scores may exhibit differences in gaze behavior and/or reaction times (H4). Furthermore, we tested how these measurements affect the diagnosis of ASD by comparing them in a regression model with the first look ratio or differential looking time score (obtained from the AL task) and reaction time (obtained from the OD task). In other words, we tested a hypothesis that the best model for explaining the diagnosis with or without ASD included both the AL measurement and the ToM index rather than the ToM index alone (H5).

We used this modified implicit FB task to overcome methodological problems and evaluate the reproducibility of the FB task and the differences in implicit ToM in adults with ASD. This study is expected to provide important insights for future ASD diagnostics and contribute to the understanding of social behavior.

2 Materials and methods

2.1 Ethics information

This study was conducted in accordance with the Declaration of Helsinki and approved by the Ethics Committee of Niigata University (approval number: 2021-0333).

2.2 Design

The experimental procedures were as follows. A participant faced the monitor, rested his or her head on a noninvasive head fixation frame (constructed in-house), and performed the task in an experimental booth with minimal external stimuli. The experiment took approximately 20 minutes and was designed to be as simple as possible to allow it to be performed during outpatient clinic hours.

The participants were required to maintain their gaze within a visual angle of 1–3°centred on a white spot (0.3°) on a 22-inch LCD monitor (BenQ, XL 2411 T, Taipei, Taiwan) with a refresh rate of 100 Hz and a viewing angle of 30°×20°from 50 cm away. Gaze positions were noninvasively captured and calibrated with an infrared camera system at a sampling rate of 300 Hz (irec_2HS, https://staff.aist.go.jp/k.matsuda/eye/). For calibration, participants were required to successively maintain their gaze on 9 spots—4 in the 4 corners of a square display area on the monitor, 4 in the midpoints of each side of the square, and 1 in the center of the square. Task control and data acquisition were performed with custom-made software (NSCS, Niigata, Japan) and PCI extensions for instrumentation (PXI) running on a real-time LabVIEW system (National Instruments, TX, USA). Movies were presented with visual presentation software (Active STIM, http://www.danko-nikolic.com/activestim/) and synchronized with the PXI system. Gaze data were sampled at 1 kHz using this system. We prepared animated movies in which an agent tracked an object (Figure 1) edited with PowerPoint® (Microsoft Corp., WA, USA). The sizes of the left and right areas of interest (AOIs) during the eye-movement measurement period were 267×202 pixels (84 dpi).

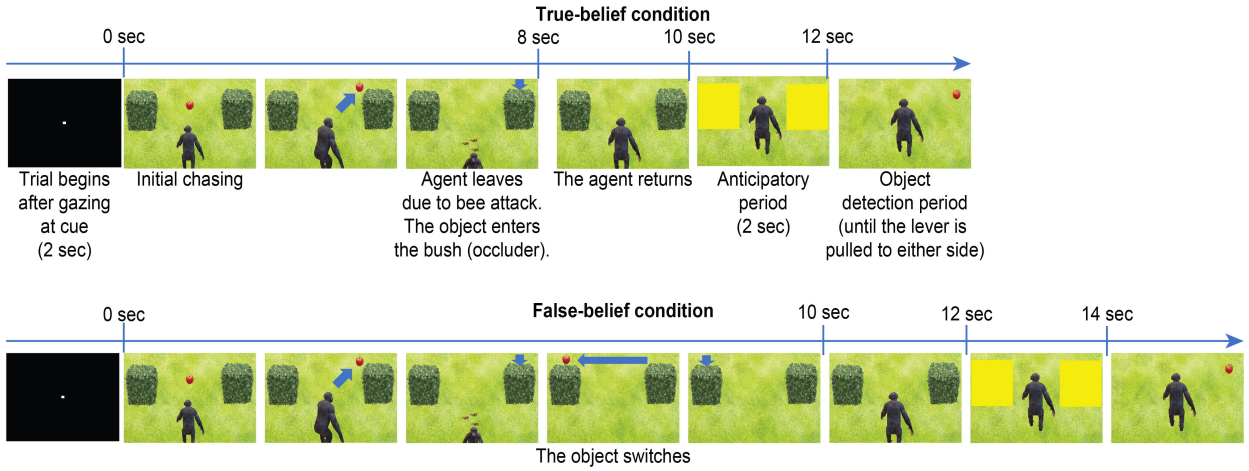

FIGURE 1
Events and timing of the trials of the TB (P+A+) and FB (P−A+) conditions. The upper figures depict the familiarization and test trials of the TB condition (P+A+). The lower figures depict the test trial of the FB condition (P−A+), where the object switches sides, reappearing on the unexpected side. The AOIs are depicted as yellow rectangles after the agent returns. The direction the agent turns is counterbalanced across trials.

2.2.1 Combination of the AL and OD paradigms

Exploiting the designs of the AL and OD paradigms, namely, that the AL paradigm measures anticipatory eye-movement data before the reappearance of an object (pre-evaluation) and that the OD paradigm measures the reaction time after the reappearance of the object (post-evaluation), we developed a hybrid paradigm combining the two (see the Supplementary Movie). The first half of the movie, which took 10 or 12 seconds, followed the AL paradigm, and the second half of the movie naturally led to the OD paradigm. At the end of the AL paradigm, the AOIs covering the left and right occluders (in this case, bushes) turned yellow for 2 seconds, during which the directions of the first look and DLTS were measured. In the second half of the movie (OD paradigm), the yellow windows and the occluders successively disappeared, which revealed the object hidden in one of the two occluders. The reaction time was defined as the latency from the object reappearance until the participants' response (pulling the lever in the left or right direction). The trial ended when the lever was pulled or when the 2-second time limit expired. In this task, the participants were just instructed to "please pull the lever in the direction of the object when it reappears", similar to the conventional instructions of the OD task. Consequently, the participants completed the entire task while they were unaware of being tested in the FB task, which satisfied the definition of an implicit FB task (i.e., the intent of the task was not indicated verbally). In addition, since the FB AOI and the control AOI were measured on the same screen, differences in spatial attention due to the FB were directly compared between the left and right sides of the same screen.

Supplementary Figure 1 presents an example of a FB formation scenario. The agent tracks and sees the object until the object is first hidden; then, the agent turns around. When the agent is absent, the object moves to the opposite side and disappears from view, by which the participants can attribute FBs to the agent. The agent then returns and attempts to find it by searching the object's original position on the basis of the agent's FB. In this case, the first half of the movie (AL paradigm) is a FB condition, whereas the second half of the movie (OD paradigm) is a P−A+ condition because the location where the object reappears is as expected for the agent (A) but unexpected for the participant (P). Therefore, the participant's lever-pull response in the P−A+ condition should be slower than that in the P+A+ condition or TB condition, in which the object reappears where both the participant's and the agent's expectations are met. However, if the participant's spatial attention is also directed to the agent's FB to some extent, then the response in the P−A+ condition would be faster than that in the P−A− condition, in which the object reappears where both the participant and the agent unexpected.

The order of all of the movies was randomized and counterbalanced according to the object position; thus, all of the participants viewed a total of 48 movies [3 (agent−object variation) × 4 (condition: P+A+, P−A−, P−A+, and P+A−) × 2 (side: left and right) × 2 (direction in which the agent rotates: left and right)]. The participants were provided only the initial instructions for the OD task. Therefore, participants were blinded to the aim and subject of the study. The participants were also blinded to the order of the conditions to which they were assigned.

2.3 Sampling plan

Individuals with ASD were recruited from the outpatient psychiatric department of Niigata University Medical and Dental Hospital and were adults with no language or intellectual disabilities. The control participants were recruited via social media as well as paper announcements. They consisted of age- and IQ-matched participants (aged 20 years or older) without a history of neurological or psychiatric disorders. IQ scores were assessed with a seven-subtest short form of the Wechsler Adult Intelligence Scale (24, 25), except when participants had already completed a full WAIS-IV test. Sample size estimates were

calculated via G*Power (26). The planned statistical analysis involved repeated-measures ANOVAs: 1) For the AL paradigm, the repeated-measures ANOVA had the following design: 2 (group: ASD vs. neurotypical (NT)) × 2 (condition: TB or FB); 2) For the OD task, the repeated-measures ANOVA had the following design: 2 (group: ASD vs. NT) × 4 (condition: P+A+, P−A−, P−A+, or P−A−). The alpha error, power, and effect size were set to 0.05, 0.95, and moderate, respectively. The total number of participants required was calculated as 36–50. In anticipation of a certain number of participants meeting the inclusion criteria, 20 participants were included in each group. The inclusion criteria were as follows: 1) those who completed familiarization (defined below), 2) subjects with a correct response rate in the OD task above 90%, and 3) control individuals with an autism-spectrum quotient (AQ) (27) score of 31 or lower. With respect to the first criterion, four TB-condition videos were presented in familiarization trials prior to the test trial, and those who exhibited at least one correct look in the last two (of four) trials (hereafter, those who completed familiarization) were included. The subjects provided written informed consent before taking part in the study.

2.4 Analysis plan

The three main steps of the present analysis as follows: (1) performing a mixed-model repeated-measures ANOVA for each measurement obtained in the FB task for adults with ASD and neurotypical adults and determining whether group differences occur in each task; (2) performing a correlational analysis between each measurement of the two belief tasks to determine if the ALT and OD paradigms are consistent; and (3) examining which variables should be included in the best-fit model for ASD diagnosis.

2.4.1 Mixed-model repeated-measures ANOVA for each measure

The main measurements included the proportion of correct first looks and the DLTS in the AL paradigm, where the first look was defined as the first time the participant's gaze remained within either the left or right AOI for more than 100 ms during the analysis period. The DLTS was defined as the ratio of the difference between the target and nontarget looking times to the total looking time.

$$\text{DLTS} = (\text{target looking time} - \text{nontarget looking time})/(\text{target looking time} + \text{nontarget looking time})$$

However, this formula tends to be biased towards 1 or −1 regardless of the length of gazing time if, for example, the target or nontarget looks are fleeting. For this reason, the denominator was fixed at 2,000 ms for the eye-movement measurement period, and the following modifications were made to transform the DLTS data into a parametric distribution:

$$\text{DLTS} = (\text{target looking time} - \text{nontarget looking time})/2000$$

The other measure was the reaction time on the OD task, which was defined as the time from the object's reappearance to the time when the lever was pulled.

ANOVAs were used to investigate the effects of location (expected or unexpected) or reaction time, belief condition (TB or FB condition for the AL paradigm; P+A+, P−A−, P−A+, or P+A− for the OD paradigm) and the interaction of both factors. Bayes factor (BF) with an evidence threshold of 3 was determined using the proportion function of the BayesFactor package in R (28).

2.4.2 Correlation analysis between the DLTS (AL measurement) and the reaction time (OD measurement)

A correlation analysis was conducted using trial-by-trial values of the DLTS and reaction time to examine the relationship between the AL and OD measurements. The reaction time was standardized for each subject. We used the z score function in MATLAB to return a z score such that the within-subject mean was centered to 0 and scaled to a standard deviation of 1.

2.4.3 Regression analysis and model selection

In the present experiment, the dependent variable was the AQ score (1), but in the main experiment, logistic regression analysis was conducted using variable 2, i.e., the NT or ASD group, and the independent variables for each measure.

1. Dependent variable p_i: Participant (i) AQ score
2. Dependent variable p_i: Participant(i) group, NT (0) or ASD (1)

Independent variable xi: Reaction time (ToM index), DLTS (FB), or AQ score

1. $p_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3}$
2. $\log (pi/1 - pi) = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \beta_3 x_{i3}$

As a supplementary measure, the AQ was used to assess the ASD severity, and the DSM-5 criteria were used to diagnose ASD.

3 Results

3.1 Testing implicit false belief attribution for neurotypical and ASD adults

Twenty participants aged 20 years or older were included in the neurotypical adult group (10 of whom were female, aged 26.7 ± 5.8 years). Five participants were excluded, 4 of whom failed the familiarization trial or poor eye measurements and one due to an AQ score > 32 (exclusion rate of 20%). Twenty participants with ASD were included in the ASD group (9 of whom were female, aged 31.6 ± 9.4 years). Six ASD participants were excluded: 5 due to failure in the familiarization trial or poor eye measurements and

one with comorbid mild intellectual disability (exclusion rate of 23%). The order in which the movies were presented, the direction in which the agent turned away, and the position of the object's appearance were counterbalanced. Following object reappearance, all of the participants pulled the lever in the correct direction with an accuracy of over 95%. As a supplementary psychological test, the AQ (mean score, 17.7 ± 5.5 for NT, 33.8 ± 5.2 for ASD [Welch's t-test, $p < 0.001$]) and the WAIS-IV (mean score, 103.9 ± 10.3 for NT, 98.8 ± 15.6 for ASD [Welch's t-test, $p = 0.295$]) were used.

A hybrid paradigm combining both AL and the OD paradigms (see the Methods for details) was designed to determine whether neurotypical adults exhibit significant gaze bias and reaction-time bias, indicating the implicit attribution of FBs to agents in movies and whether these two successively acquired measures are consistent within individuals. In the last scene, the movie is terminated when the participant pulls a lever to the left or right after the object reappears. The movie does not show the agents pursuing their prey to the end to minimize the learning effect. This methodology followed previous work (29), in which the interruption of FB-based searching for the object prevented the modulation of gaze behavior (30). To assess this learning effect, we first divided all of the data into four time bins to examine the learning effect across trials within subjects in the neurotypical group (Supplementary Figures 6A–C). Two-way ANOVA indicated that there were no significant main effects of the condition (TB or FB condition) [Bayes factor (BF) = 1.464 for the first correct look ratio, BF = 0.267 for the DLTS], time bin [BF = 0.168, BF = 0.173, respectively] and no interaction between the condition and time bin [BF = 0.311, BF = 0.300, respectively]. *Post hoc* multiple comparisons via two-tailed tests were not significant [Holm test, BF < 3] for both time-bin combinations. Regarding reaction time (OD measurement), a two-way ANOVA indicated that there was no significant main effect of time bin [BF = 0.465] or a significant interaction between the condition and time bin and condition [BF = 0.034]. *Post hoc* multiple comparisons via two-tailed tests were not significant [Holm test, BF < 3] for both time-bin combinations. These results indicated that there was no learning effect for any measurements (the first look ratio, DLTS, or reaction time). Therefore, in this main experiment, the data for analysis were summarized as trial averages for each condition. However, to analyze the correlation between the DLTS and reaction time, data for each trial were used.

In the neurotypical group, regarding the proportion of correct first looks in the main experiment (Figure 2A), a Bayes factor analysis of the two-way ANOVA showed that the BF value for the main effect of condition (TB or FB condition) was negligible [BF = 0.224, $F(1,19) = 0.51$, $p = 0.483$, $\eta p^2 = 0.026$], the BF value for the main effect of correct/incorrect first looks was very strong [BF = 37804, $F(1,19) = 10.664$, $p = 0.004$, $\eta p^2 = 0.36$] and the BF value for the interaction was negligible [BF = 0.903, $F(1,19) = 3.671$, $p = 0.07$, $\eta p^2 = 0.162$]. These findings suggest that the ratio of correct first looks significantly differed from that of incorrect first looks in any condition. For reference, we assumed a simple main effect in the interaction and performed multiple comparisons (two-tailed test) with paired means for each level. The BF value for the main effect of the correct/incorrect first look-in-the TB condition was significant [BF= 76.435, $F(19,19) = 8.891$, adjusted $p = 0.01$, $\eta p^2 = 0.319$] but not significant in the FB condition [BF= 1.015, $F(19,19) = 2.678$, adjusted $p = 0.118$, $\eta p^2 = 0.124$]. Specifically, the mean correct first look ratio in the TB condition (0.616) was significantly greater than the mean incorrect first look ratio (0.261) but not in the FB condition (0.529 vs. 0.334). Next, a BF analysis with one-way ANOVA for the DLTS showed that the BF value for the main effect of the mean DLTS significantly differed from the chance level of 0 in the TB condition [mean = 0.268, BF = 42.763, $F(1,19) = 11.134$, $p = 0.003$, $\eta p^2 = 0.369$], and even in the FB condition [mean = 0.188, BF = 3.738, $F(1,19) = 5.281$, $p = 0.033$, $\eta p^2 = 0.217$] (Figure 2B). Third, regarding the reaction time, a BF analysis of the one-way ANOVA was performed across conditions (P+A+, P−A−, P−A+, P+A−), and the main effect of condition was highly significant [BF = 486.562, $F(3,57) = 9.26$, $p < 0.001$, $\eta p^2 = 0.328$]. Multiple comparisons (two-tailed, Holm's method) using paired means for each level revealed that the mean reaction time in the P+A+ condition (580 ms) was significantly shorter than that in the P−A− condition (655 ms) [BF = 19.087, $t(19) = 3.5538$, adjusted $p = 0.0051$], and the mean reaction time in the P−A− condition was

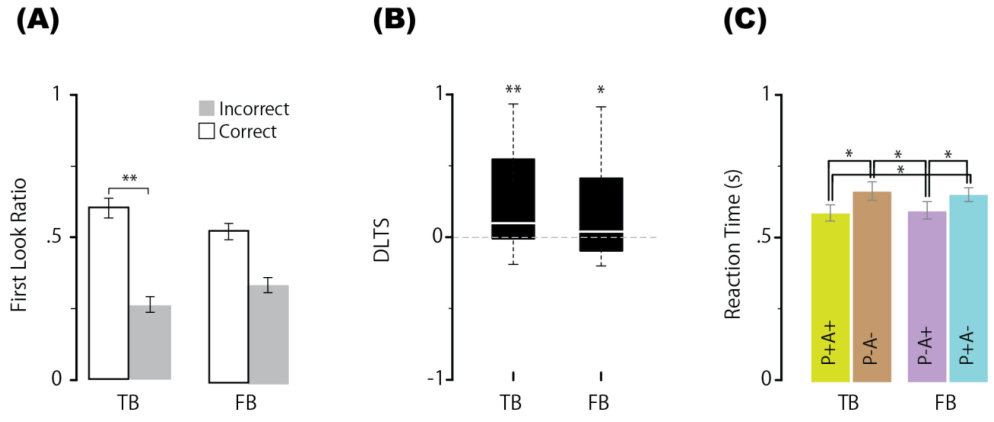

FIGURE 2
Proportion of first looks (correct or incorrect) for each condition **(A)**, differential looking time score (DLTS) **(B)**, and reaction times in the P+A+, P−A−, P−A+, and P+A− conditions **(C)** in neurotypical group. Error bars represent the standard error of within-subject effects. ** indicates a BF > 10, and * indicates a BF > 3. N=20. TB, true belief; FB, false belief.

significantly longer than that in the P−A+ condition (587 ms) [BF = 12.806, t(19) = 3.348, adjusted p = 0.0060]. These results replicate those of previous studies, such as Kovács et al. (9), indicating that in addition to the participants' own beliefs, the agent's beliefs influenced the reaction time. Additionally, the mean reaction time in the P+A− condition (643 ms) was significantly longer than that in the P+A+ condition (579 ms) [BF = 20.581, t(19) = 3.5923, adjusted p = 0.0073] and P−A+ condition (587 ms) [BF = 12.806, t(19) = 2.9, adjusted p = 0.013] (Figure 2C). Therefore, simply seeing the agent automatically made neurotypical participants attribute beliefs to the agent and that the agent's beliefs might be represented and sustained like the participants' own beliefs.

In sharp contrast to the results for the neurotypical group, a two-way ANOVA for the first look ratios in the ASD group revealed that the main effects of neither condition [BF = 0.229, F(1,19) = 0.024, p = 0.879, ηp^2 = 0.001] nor correct/incorrect first looks [BF = 0.82, F(1,19) = 2.092, p = 0.164, ηp^2 = 0.099] were significant. The BF value for the interaction was very strong [BF = 919173, F(1,19) = 31.744, p < 0.001, ηp^2 = 0.626]. One-way ANOVA revealed that the BF value for the main effect of the correct/incorrect first look ratio was significant in the TB condition [BF = 117.790, F(19,19) = 16.907, adjusted p < 0.001, ηp^2 = 0.471] but nonsignificant in the FB condition [BF = 2.202, F(19,19) = 4.269, adjusted p = 0.052, ηp^2 = 0.184]. In the TB condition, the mean correct first look ratio (0.528) was substantially greater than the mean incorrect first look ratio (0.302) but not in the FB condition (0.357 vs. 0.470) (Figure 3A). Next, a BF analysis with one-way ANOVA for the DLTS showed that the BF value for the main effect of the mean DLTS in the TB condition significantly differed from the chance level [mean = 0.154, BF = 412.097, F(1,19) = 17.041, p < 0.001, ηp^2 = 0.473] but not in the FB condition [mean = −0.035, BF = 0.638, F(1,19) = 1.478, p = 0.238, ηp^2 = 0.072] (Figure 3B). Third, regarding the reaction time, a BF analysis of the one-way ANOVA was performed across conditions, and the main effect of condition was significant [BF = 45.706, F(3,57) = 6.634, p < 0.001, ηp^2= 0.259]. Multiple comparisons using paired means for each level revealed that the mean reaction time in the P+A+ condition (669 ms) was not significantly shorter than that in the P−A− condition (700 ms) [BF = 0.681, t(19) = 1.59, adjusted p = 0.171], and the mean reaction time in the P−A+ condition (694 ms) was not significantly shorter than that in the P−A− condition [BF = 0.248, t(19) = 0.3847, adjusted p = 0.259]. The mean reaction time in the P+A− condition (641 ms) was significantly shorter than that in the P−A− condition [BF = 44.435, t(19) = 3.981, adjusted p = 0.002] and P−A+ condition [BF = 2259.467, t(19) = 5.963, adjusted p < 0.001] (Figure 3C). Overall, the results of the FB condition in the ASD group were reversed compared with those in the neurotypical group. For reference, multiple two-tailed comparisons were conducted for each measurement to evaluate the main effects between groups (neurotypical vs. ASD) under the FB condition. As a result, significant main effects were found across all measurements: for the correct first look ratio (0.529 vs. 0.357), BF = 5.093, F(1,38) = 6.678, adjusted p = 0.027, ηp^2 = 0.163; for DLTS (0.188 vs. −0.035), BF = 3.802, F(1,38) = 6.61, adjusted p = 0.028, ηp^2 = 0.148; and for reaction time under the P−A+ condition (587 vs. 694), BF = 10.139, F(1,38) = 9.385, adjusted p = 0.008, ηp^2 = 0.198.

To further confirm the relationship between the AL and OD paradigms, a correlation analysis was conducted using the trial-by-trial DLTS and reaction time. The reaction time was normalized for each subject. The results in the neurotypical group revealed moderate to strong correlations between the DTLS and reaction time in the TB (P+A+) condition [r = −0.144, p = 0.034, BF = 2.76, ρ_95% CI: −0.267 to −0.143], TB (P−A−) condition [r = 0.146, p = 0.044, BF = 2.341, ρ_95% CI: 0.022 to 0.148], FB (P−A+) condition [r = −0.173, p = 0.011, BF = 7.11, ρ_95% CI: −0.296 to −0.168] and FB (P+A−) condition [r = 0.162, p = 0.021, BF = 4.286, ρ_95% CI: 0.036 to 0.162]. Thus, there was a significant correlation between the data obtained with the two paradigms, indicating that anticipatory gaze, reflecting belief attribution to the agent, strongly affected reaction time (Figure 4A). In the ASD group, the correlation was observed only in the TB conditions, i.e., the TB (P+A+) condition [r = −0.159, p = 0.025, BF = 3.703, ρ_95% CI: −0.286 to −0.156], TB (P−A−) condition [r = 0.148, p = 0.031, BF = 2.979, ρ_95% CI: 0.030 to 0.150], but not in the FB (P−A+)

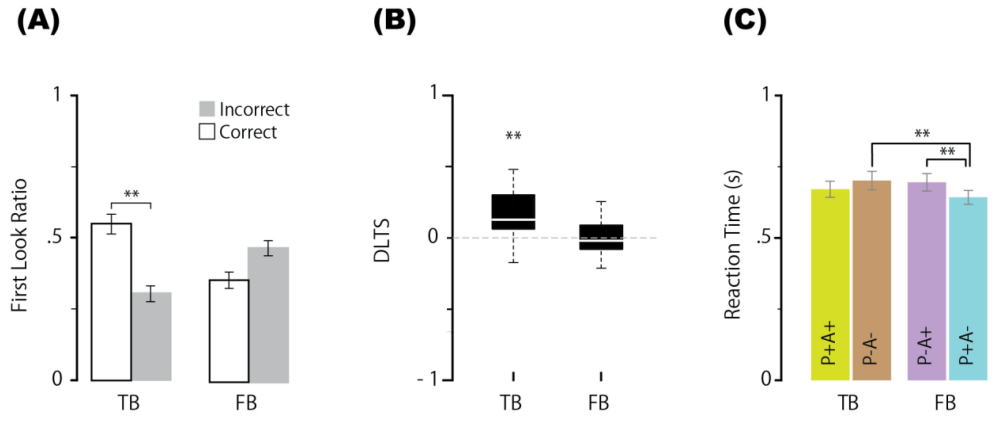

FIGURE 3
Proportion of first looks (correct or incorrect) for each condition **(A)**, DLTS **(B)**, and reaction times in the P+A+, P−A−, P−A+, and P+A− conditions **(C)** in ASD group. Error bars represent the standard error of within-subject effects. ** indicates a BF > 10. N=20. TB, true belief; FB, false belief.

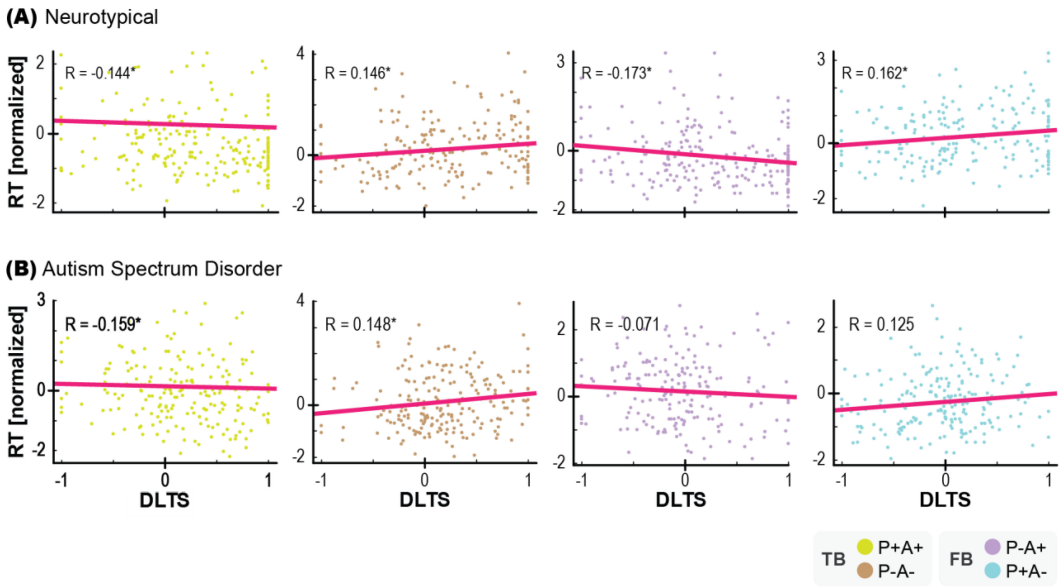

FIGURE 4
Relationship between the DLTS and reaction times in each trial in each condition in neurotypical group **(A)** and ASD group **(B)**. Reaction times were normalized for each subject. * indicates $p < 0.05$. N=20 each.

condition [$r = -0.071$, p = 0.322, BF = 0.444, ρ_95% CI: −0.207 to −0.083] or the FB (P+A−) condition [r = 0.125, p = 0.076, BF = 1.452, ρ_95% CI: 0.017 to 0.127] (Figure 4B). These findings provide evidence that AL and OD are different ways of assessing the same symptom of lack of spontaneous mental attribution to others, which is one of characteristic of ASD.

3.2 Regression analysis and model selection for AQ score and ASD diagnosis

In addition, to examine the contribution of each measurement (first look ratio, DLTS, or reaction time) to the AQ score, a regression analysis was conducted with the AQ score as the dependent variable and each measurement as the independent variable. A BF analysis was subsequently conducted for the following interaction models, and model selection was subsequently performed (Supplementary Table 2).

Y: AQ (autism-spectrum quotient)
x1: ToM index (reaction time difference between the P−A−and P−A+ conditions)
x2: Proportion of correct first looks (TB condition)
x3: Proportion of correct first looks (FB condition)
x4: Differential looking time score (TB condition)
x5: Differential looking time score (FB condition)
Y ~ x1 + x2 + x3 + x4 + x5 (for regression analysis and model selection)

In the regression analysis with AQ as the dependent variable, none of the regression equations were significantly correlated with

TABLE 1 Regression results and model selection with the ASD diagnosis (Y) as the dependent variable and the ToM index (x1), FL in the FB condition (x3) and DLTS in the FB condition (x5) as the independent variables. ToM_id, ToM index; DL_FB, DLTS in the FB condition; FL_FB, correct first look ratio in the FB condition; AIC, Akaike's Information Criterion; BIC, Bayesian information criterion.

	Model (n = 40)					
	Y~x1	Y~x3	Y~x5	Y~x1+x3	Y~x1+x5	Y~x1+x3+x5
Intercept	0.333 (0.373)	2.146* (0.976)	0.184 (0.345)	1.858 (0.981)	0.407 (0.387)	1.411 (1.511)
ToM_id	−1.491* (0.592)			−1.201 (0.613)	−1.247* (0.618)	−1.188 (0.619)
FL_FB		−5.058* (2.286)		−3.733 (2.292)		−2.576 (3.758)
DL_FB			−3.543* (1.678)		−2.617 (1.684)	−1.053 (2.774)
p	0.003	0.006	0.009	0.002	0.003	0.007
AIC	50.923	51.991	52.668	49.374	49.721	51.227
BIC	54.301	55.368	56.046	54.440	54.788	57.983

Significance: * indicates $p < 0.05$.

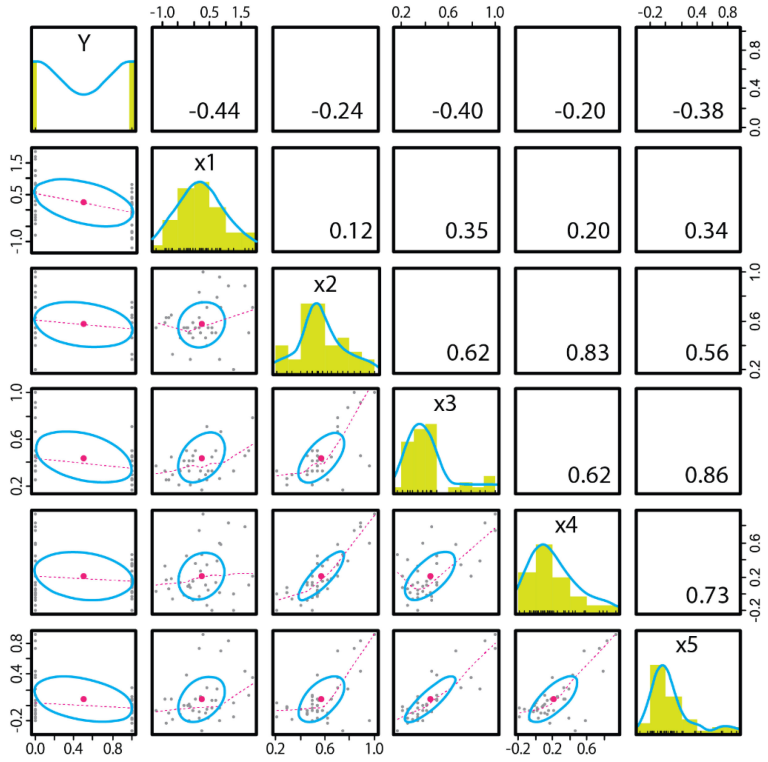

FIGURE 5
Correlation coefficient between the binary variable in ASD diagnosis (on the Y axis) and all measurements (on the X axis). N=40.

AQ [BF < 3, p > 0.1]. The AQ score was not correlated with any measurements.

Next, we constructed a model equation with the diagnosis of ASD or neurotypical as the dependent variable (Table 1, Figure 5).

Y: ASD diagnosis (0: Neurotypical, 1: ASD)
x1: ToM index
x2: Proportion of correct first looks (TB condition)
x3: Proportion of correct first looks (FB condition)
x4: Differential looking time score (TB condition)
x5: Differential looking time score (FB condition)
Y ~ x1 + x2 + x3 + x4 + x5 (for regression analysis and model selection)

The models selected in the regression analysis were, in order of the maximum BF value, Y~x1+x3 ([BF=12.741, adj. R2 = 0.225]), Y~x1+x5 ([BF=10.553, adj. R2 = 0.215]) and Y~x1 ([BF=9.215, adj. R2 = 0.172]). The stepwise method of model selection revealed that first, adding x1 (ToM index) resulted in a BIC difference of −4.906. Next, adding x3 (FL_FB i.e., correct first look ratio in the false belief condition) resulted in a BIC difference of −0.0126, indicating that these combinations were the optimal models for the minimum BIC [p=0.00339, adj. R2 = 0.225]. In the correlation matrix of variables (Figure 5), the correlations between x2–x5 were greater than 0.5. Since there was a considerable amount of multicollinearity, which can be a variance widening factor, combining pairs of these measures (x2–x5) is not recommended.

The ASD diagnosis was strongly correlated with the ToM index (obtained from the OD task) and the AL measurements (especially the correct first look ratio in the FB condition or DLTS in the FB condition). Stepwise methods indicate that the best model to explain the ASD diagnosis would combine the ToM index and one of the AL measurements rather than using the ToM index alone.

4 Discussion

The purpose of the present study was to test the reliability and convergent validity of the implicit FB tasks and their usefulness for ASD diagnosis. We developed a standardized, reliable, and valid implicit ToM measurement. This method is a combination of two typical conventional implicit measures, the AL and OD methods, and is expected to be an improved implicit task that exploits the strengths of both methods. In recent years, there have been many challenges associated with the AL method, especially its fragility and unreliability, due to its low engagement and high exclusion rate. In addition, the results of similar AL methods were inconsistent across tasks, which raised the question of whether there is a (homogeneous) concept of spontaneous ToM that is tapped into by different tasks (15, 21, 31). For the OD method, which was originally developed by Kovacs, Téglás, and Endress et al., some vulnerabilities of the task have also been noted, such as the confounding factor of the attention-grabbing sound stimuli in the movie for reaction time and the inability to ignore psychological refractory periods due to trial repetition (32). To overcome these problems, we inserted the AL method into the OD

paradigm without any sound stimulus and used repeated trial averages as AL measurements. These procedures enabled us to obtain robust data by offsetting the inherent fragility of the task. For the purpose of eye movement measurement, the face was fixed, and the viewpoint was set to the agent's viewpoint (similar to the OD method) to create a more engaging environment. Furthermore, by using a 2-alternative, forced-choice paradigm, in which the reaction time was measured by tipping the left and right levers, the target AOI was placed on the same screen in all conditions, thereby minimizing differences between task conditions. These modifications were made in accordance with the conventional method, and the results generally replicated the results of previous studies in a neurotypical group. The first look ratio was significantly greater for correct AOIs than for incorrect AOIs in the TB condition for both the neurotypical and ASD groups, and although there was no significant difference between the two in the FB condition, there was a trend towards correct > incorrect AOIs in the neurotypical group and vice versa in the ASD group. The DLTS results replicated those in previous studies by Senju (11) and Schneider et al. (29). And Wu et al. (33) also succeeded in replicating positive results with a multi-trial paradigm, which suggests that increasing the number of trials not only effectively reduced the high dropout rate but also decreased error variance. The reaction time (RT) results were significantly different from those of FB (P−A+) in the neurotypical group when TB (P−A−) was used as the baseline, and no such difference was found in the ASD group. In addition, the RTs in the FB (P+A−) condition tended to be longer in the neurotypical group and, conversely, shorter in the ASD group, but this result is consistent with the trend that the greater the agent's FB attribution, the longer the RTs in the FB (P+A−) condition.

In the present study, multiple measures were obtained in a single paradigm, allowing a within-subject comparison of multiple measures, and the results showed that each measure of the AL and OD methods was robust and independent. The correlation analysis of both methods revealed a significant correlation. In the neurotypical group, correlations were found in both the TB and FB conditions. However, the ASD group showed weak correlation in the FB condition, probably because the distribution of DLTS data was centralized. These correlation results suggest that both tasks exhibit the same ToM ability. Furthermore, we also conclude that the consistency between the results of the AL method as the pre-evaluation measure and the OD method as the post-evaluation measure suggests that there is a time-fixed correlation between the two. In other words, it is possible that an anticipatory gaze at FBs directly affects reaction speed. In the regression analysis, no multicollinearity was found between the measures of the AL and OD methods. Although no measurements were correlated with AQ scores, ASD diagnosis was correlated with any of the measurements. Furthermore, the results of the regression analysis and stepwise model selection revealed that the model equation for an ASD diagnosis that combined two or more measures significantly increased the degree of fit compared with that of each measure alone. In other words, not only the measure of the OD method (ToM index) but also those of the AL method were found to contribute effectively to the ASD diagnosis. These results suggest that the measures of the AL and OD methods are complementary to each other which derive from the same spontaneous ToM ability. It should be noted that the AL and OD methods have never been directly compared and validated in the context of ASD diagnosis before.

There are certain observations regarding the functional brain similarities between the AL and OD methods. fMRI studies have shown that reaction times involving FBs are associated with the right temporal-parietal junction (rTPJ) (34–40). The AL method has also been shown to activate regions around the TPJ in implicit as well as explicit tasks (41). In general, the TPJ is spatiotemporally located between the visual cortex and the mPFC in the network involved in mentalizing (42), and the dmPFC is activated when explicit FB attributions are made in mentalizing tasks (43–45). Inherently, the TPJ and frontal cortex are also closely involved in the acquisition of ToM abilities, and the ToM network, especially between the rTPJ and the prefrontal cortex, is considered as an important neural basis for the emergence of a full-fledged ToM around age 4 (46). Even if the counterargument is that implicit FB tasks are not tasks that require higher-order cognitive functions, the involvement of the TPJ is at least obvious from previous imaging studies, and in the immediate context, implicit FB attribution abilities play a central role in communication. Thus, innate functional differences in TPJ emerge in social situations that require immediate spontaneous communication, which is important for ASD diagnosis.

The prevalence of developmental disorders has increased in recent years (47, 48), especially as more cases of developmental disorders are first diagnosed in adulthood, with a large population being missed below the threshold (49). There is still a lack of measurements that can serve as diagnostic markers (50). Although many meta-analyses of implicit FB tasks have resulted in a widespread negative view of these tasks owing to their high variance across tasks, it is desirable that the results of this direct comparison between tasks provide a reevaluation of the usefulness of FB tasks. Although Nijhof et al. were unable to demonstrate consistency between ASD diagnosis and the behavioral data (39, 40), we successfully demonstrated more robust behavioral data on ASD diagnosis or not, and we expect this paradigm to be extended to a variety of subjects and to be neurologically supported in the future.

As a limitation, the sample size of the present study was determined based on statistical calculations (26) but was not yet large enough to provide normative data split by factors such as IQ, the AQ, sex, and age. Currently, a larger-scale examination of the issue is underway, led by Schuwerk et al. (registered in Child Development in 2021). In addition, our scenarios were monotonous, discrete stimuli of short duration, which does not allow for an expanded interpretation of how individuals would respond in a scenario with more contextual information. Another problem with the task structure is that the intertrial interval is as short as 2 seconds, so the effect of the psychological refractory period cannot be ignored, and the variability caused by lever toppling (the levers have play) cannot be accounted for. The characteristics of Schneider et al.'s experiment were that they dared to avoid paying attention to the moving images so as not to let the subjects explore the intention of the story (29), but our experiment, on the contrary, required the subjects' engagement.

Our task was more in line with real-life communication styles, as it required immediate and spontaneous responses within a short

time constraint. Spontaneous and immediate mentalizing ability is a core component of communication problems. This study is important not only for the pathophysiology of ASD but also for elucidating the basic mechanisms of social communication skills, and further research on implicit ToM abilities is warranted.

5 Conclusion

Inspired by the possibility that implicit FB tasks could help diagnose ASD (10), we efficiently combined two representative methods of implicit tasks. The results revealed a generally positive replication of previous research and significant correlations with an ASD diagnosis. Importantly, the implicit nature of this experiment resulted in robust results with low exclusion rates with repeated data. This method provided an independent assessment of the general individual characteristics that distinguish ASD from neurotypical individuals. These findings can potentially contribute to the future development of gaze bias or reaction time biomarkers as diagnostic tools for ASD.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Ethics Committee of Niigata University (approval number: 2021-0333). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

KO: Conceptualization, Methodology, Software, Data curation, Formal analysis, Writing – original draft, Writing – review & editing, Visualization, Investigation, Formal analysis. RI: Writing – review & editing, Investigation. KK: Writing – review & editing, Validation, Supervision, Software, Resources, Project administration, Funding acquisition. JE: Writing – review & editing, Validation, Supervision, Resources, Project administration, Funding acquisition. TS: Writing – review & editing, Supervision, Project administration, Funding acquisition. IH: Writing – review & editing, Validation, Supervision, Project administration, Funding acquisition.

Funding

The author(s) declare that financial support was received for the research, authorship, and/or publication of this article. We are thankful for the financial support provided by the Japan Society for the Promotion of Science (grants KAKENHI 26293261 to TS and KAKENHI 19H01038 to IH) and by AMED (grant number JP24wm0625205 to I.H.).

Acknowledgments

We thank the Niigata University Hospital outpatient staff for their help in collecting the data. We also thank M. Nagahama and R. Sato for technical assistance in the current study.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as potential conflicts of interest.

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Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpsyt.2024.1189777/full#supplementary-material

References

1. American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders (DSM-5-TR)*. Washington, DC: American Psychiatric Publishing (2013).

2. Baron-Cohen S. Autism: the empathizing-systemizing (E-S) theory. *Ann N Y. Acad Sci.* (2009) 1156:68–80. doi: 10.1111/j.1749-6632.2009.04467.x

3. Premack D, Woodruff G. Does the chimpanzee have a theory of mind? *Behav Brain Sci.* (1978) 1:515–26. doi: 10.1017/s0140525x00076512

4. Baron-Cohen S, Leslie AM, Frith U. Does the autistic child have a "theory of mind"? *Cognition*. (1985) 21:37–46. doi: 10.1016/0010-0277(85)90022-8

5. Frith U. Mind blindness and the brain in autism. *Neuron*. (2001) 32:969–79. doi: 10.1016/s0896-6273(01)00552-9

6. Baron-Cohen S. Theory of mind in autism: A fifteen year review. In: Baron-Cohen S, TagerFlusberg H, Cohen &DJ, editors. *Understanding other mind: Perspectives from*

developmental cognitive neuroscience. Oxford University Press, New York (2000). p. 3–20.

7. Onishi KH, Baillargeon R. Do 15-month-old infants understand false beliefs? *Science*. (2005) 308:255–8. doi: 10.1126/science.1107621

8. Southgate V, Senju A, Csibra G. Action anticipation through attribution of false belief by 2-year-olds. *Psychol Sci*. (2007) 18:587–92. doi: 10.1111/j.1467-9280.2007.01944.x

9. Kovács AM, Teglas E, Endress AD. The social sense: susceptibility to others' beliefs in human infants and adults. *Science*. (2010) 330:1830–4. doi: 10.1126/science.1190792

10. Senju A, Southgate V, White S, Frith U. Mindblind eyes: an absence of spontaneous theory of mind in Asperger syndrome. *Science*. (2009) 325:883–5. doi: 10.1126/science.1176170

11. Senju A. Atypical development of spontaneous social cognition in autism spectrum disorders. *Brain Dev*. (2013) 35:96–101. doi: 10.1016/j.braindev.2012.08.002

12. Baillargeon R, Buttelmann D, Southgate V. Invited commentary: interpreting failed replications of early false-belief findings: methodological and theoretical considerations. *Cogn. Dev*. (2018) 46:112–24. doi: 10.1016/j.cogdev.2018.06.001

13. Kulke L, Rakoczy H. Implicit theory of mind - an overview of current replications and non-replications. *Data Brief*. (2018) 16:101–4. doi: 10.1016/j.dib.2017.11.016

14. Schuwerk T, Priewasser B, Sodian B, Perner J. The robustness and generalizability of findings on spontaneous false belief sensitivity: a replication attempt. *R Soc Open Sci*. (2018) 5:172273. doi: 10.1098/rsos.172273

15. Kulke L, Reiß M, Krist H, Rakoczy H. How robust are anticipatory looking measures of theory of mind? Replication attempts across the life span. *Cogn. Dev*. (2018) 46:97–111. doi: 10.1016/j.cogdev.2017.09.001

16. Kulke L, von Duhn B, Schneider D, Rakoczy H. Is implicit theory of mind a real and robust phenomenon? Results from a systematic replication study. *Psychol Sci*. (2018) 29:888–900. doi: 10.1177/0956797617747090

17. Kulke L, Wubker M, Rakoczy H. Is implicit theory of mind real but hard to detect? Testing adults with different stimulus materials. *R Soc Open Sci*. (2019) 6:190068. doi: 10.1098/rsos.190068

18. Poulin-Dubois D, Azar N, Elkaim B, Burnside K. Testing the stability of theory of mind: a longitudinal approach. *PloS One*. (2020) 15:e0241721. doi: 10.1371/journal.pone.0241721

19. Kampis D, Karman P, Csibra G, Southgate V, Hernik M. A two-lab direct replication attempt of Southgate, Senju and Csibr. *R Soc Open Sci*. (2021) 8:210190. doi: 10.1098/rsos.210190

20. Kulke L, Hinrichs MAB. Implicit theory of mind under realistic social circumstances measured with mobile eye-tracking. *Sci Rep*. (2021) 11:1215. doi: 10.1038/s41598-020-80614-5

21. Poulin-Dubois D, Yott J. Probing the depth of infants' theory of mind: disunity in performance across paradigms. *Dev Sci*. (2018) 21:e12600. doi: 10.1111/desc.12600

22. Rakoczy H. Foundations of theory of mind and its development in early childhood. *Nat Rev Psychol*. (2022) 1:223–35. doi: 10.1038/s44159-022-00037-z

23. Wellman HM, Cross D, Watson J. Meta-analysis of theory-of-mind development: the truth about false belief. *Child Dev*. (2001) 72:655–84. doi: 10.1111/1467-8624.00304

24. Wechsler D. *Wechsler Adult Intelligence Scale–Fourth Edition (WAIS–IV)*. San Antonio, TX: The Psychological Corporation (2008).

25. Meyers JE, Zellinger MM, Kockler T, Wagner M, Miller RM. A validated seven-subtest short form for the WAIS-IV. *Appl Neuropsychol. Adult*. (2013) 20:249–56. doi: 10.1080/09084282.2012.710180

26. Faul F, Erdfelder E, Lang AG, Buchner A. G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods*. (2007) 39:175–91. doi: 10.3758/bf03193146

27. Baron-Cohen S, Wheelwright S, Skinner R, Martin J, Clubley E. The autism-spectrum quotient (AQ): evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *J Autism Dev Disord*. (2001) 31:5–17. doi: 10.1023/a:1005653411471

28. Morey RD, Hoekstra R, Rouder JN, Lee MD, Wagenmakers EJ. The fallacy of placing confidence in confidence intervals. *Psychon. Bull Rev*. (2016) 23:103–23. doi: 10.3758/s13423-015-0947-8

29. Schneider D, Slaughter VP, Bayliss AP, Dux PE. A temporally sustained implicit theory of mind deficit in autism spectrum disorders. *Cognition*. (2013) 129:410–7. doi: 10.1016/j.cognition.2013.08.004

30. Schuwerk T, Vuori M, Sodian B. Implicit and explicit Theory of Mind reasoning in autism spectrum disorders: the impact of experience. *Autism*. (2015) 19:459–68. doi: 10.1177/1362361314526004

31. Heyes C. Submentalizing: i am not really reading your mind. *Perspect Psychol Sci*. (2014) 9:131–43. doi: 10.1177/1745691613518076

32. Phillips J, Ong DC, Surtees AD, Xin Y, Williams S, Saxe R, et al. A second look at automatic theory of mind: reconsidering Kovacs, Teglas, and Endres. *Psychol Sci*. (2015) 26:1353–67. doi: 10.1177/0956797614558717

33. Wu R, Lim JT, Ahmed Z, Berger R, Acem E, Chowdhury I, et al. Do autistic adults spontaneously reason about belief? A detailed exploration of alternative explanations. *R Soc Open Sci*. (2024) 11:231889. doi: 10.1098/rsos.231889

34. Kovács AM, Kuhn S, Gergely G, Csibra G, Brass M. Are all beliefs equal? Implicit belief attributions recruiting core brain regions of theory of mind. *PloS One*. (2014) 9:e106558. doi: 10.1371/journal.pone.0106558

35. Schurz M, Radua J, Aichhorn M, Richlan F, Perner J. Fractionating theory of mind: a meta-analysis of functional brain imaging studies. *Neurosci Biobehav Rev*. (2014) 42:9–34. doi: 10.1016/j.neubiorev.2014.01.009

36. Hyde DC, Betancourt MA, Simon CE. Human temporal-parietal junction spontaneously tracks others' beliefs: a functional near-infrared spectroscopy study. *Hum Brain Mapp*. (2015) 36:4831–46. doi: 10.1002/hbm.22953

37. Bardi L, Desmet C, Nijhof A, Wiersema JR, Brass M. Brain activation for spontaneous and explicit false belief tasks overlaps: new fMRI evidence on belief processing and violation of expectation. *Soc Cogn. Affect. Neurosci*. (2017) 12:391–400. doi: 10.1093/scan/nsw143

38. Bardi L, Six P, Brass M. Repetitive TMS of the temporo-parietal junction disrupts participant's expectations in a spontaneous theory of mind task. *Soc Cogn. Affect. Neurosci*. (2017) 12:1775–82. doi: 10.1093/scan/nsx109

39. Nijhof AD, Bardi L, Brass M, Wiersema JR. Brain activity for spontaneous and explicit mentalizing in adults with autism spectrum disorder: an fMRI study. *NeuroImage Clin*. (2018) 18:475–84. doi: 10.1016/j.nicl.2018.02.016

40. Boccadoro S, Cracco E, Hudson AR, Bardi L, Nijhof AD, Wiersema JR, et al. Defining the neural correlates of spontaneous theory of mind (ToM): an fMRI multi-study investigation. *Neuroimage*. (2019) 203:116193. doi: 10.1016/j.neuroimage.2019.116193

41. Naughtin CK, Horne K, Schneider D, Venini D, York A, Dux PE. Do implicit and explicit belief processing share neural substrates? *Hum Brain Mapp*. (2017) 38:4760–72. doi: 10.1002/hbm.23700

42. Tan KM, Daitch AL, Pinheiro-Chagas P, Fox KCR, Parvizi J, Lieberman MD. Electrocorticographic evidence of a common neurocognitive sequence for mentalizing about the self and others. *Nat Commun*. (2022) 13:1919. doi: 10.1038/s41467-022-29510-2

43. Ma N, Vandekerckhove M, Overwalle FV, Seurinck R, Fias W. Spontaneous and intentional trait inferences recruit a common mentalizing network to a different degree: Spontaneous inferences activate only its core areas. *Soc Neurosci*. (2011) 6:123–38. doi: 10.1080/17470919.2010.485884

44. Molenberghs P, Johnson H, Henry JD, Mattingley JB. Understanding the minds of others: A neuroimaging meta-analysis. *Neurosci Biobehav Rev*. (2016) 65:276–91. doi: 10.1016/j.neubiorev.2016.03.020

45. Schurz M, Radua J, Tholen MG, Maliske L, Margulies DS, Mars RB, et al. Toward a hierarchical model of social cognition: A neuroimaging meta-analysis and integrative review of empathy and theory of mind. *Psychol Bull*. (2021) 147:293–327. doi: 10.1037/bul0000303

46. Xiao Y, Geng F, Riggins T, Chen G, Redcay E. Neural correlates of developing theory of mind competence in early childhood. *NeuroImage*. (2019) 184:707–16. doi: 10.1016/j.neuroimage.2018.09.079

47. Christensen DL, Baio J, Van Naarden Braun K, Bilder D, Charles J, Constantino JN, et al. Prevalence and characteristics of autism spectrum disorder among children aged 8 years–autism and developmental disabilities monitoring network, 11 sites, United State. *MMWR Surveill. Summ*. (2016) 65:1–23. doi: 10.15585/mmwr.ss6503a1

48. Maenner MJ, Shaw KA, Bakian AV, Bilder DA, Durkin MS, Esler A, et al. Prevalence and characteristics of autism spectrum disorder among children aged 8 years - autism and developmental disabilities monitoring network, 11 sites, United State. *MMWR Surveill. Summ*. (2021) 70:1–16. doi: 10.15585/mmwr.ss7011a1

49. Nyrenius J, Eberhard J, Ghaziuddin M, Gillberg C, Billstedt E. Prevalence of autism spectrum disorders in adult outpatient psychiatry. *J Autism Dev Disord*. (2022) 52:3769–79. doi: 10.1007/s10803-021-05411-z

50. Walsh P, Elsabbagh M, Bolton P, Singh I. In search of biomarkers for autism: scientific, social and ethical challenges. *Nat Rev Neurosci*. (2011) 12:603–12. doi: 10.1038/nrn3113

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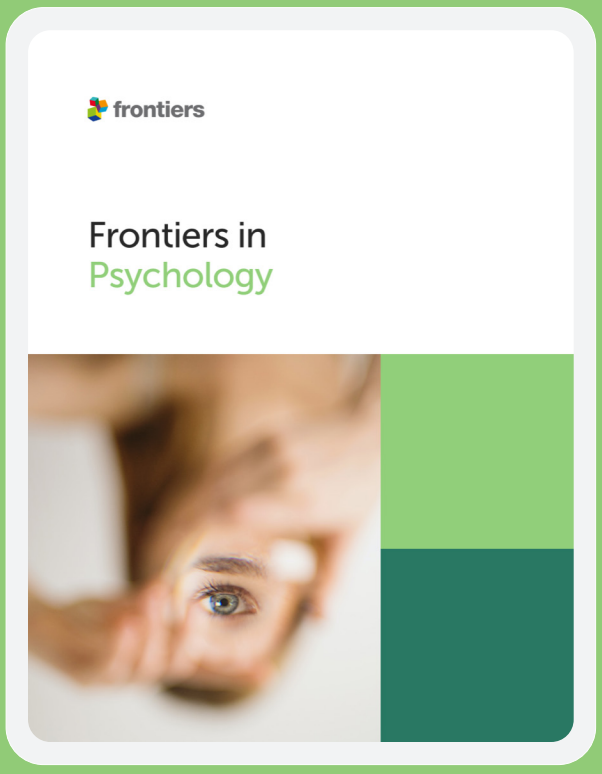

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