The importance of the body-mind relationship in mental functioning and development of body-focused disorders in adolescence, volume II

Edited by
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The importance of the body-mind relationship in mental functioning and development of body-focused disorders in adolescence, volume II

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Table of
contents

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Body image construction and mental health levels among college students: a data survey of Chinese university students

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Background: With the rapid changes in body image construction brought about by the upgrading of consumption in China, trend-seeking college students are faced with mental health problems brought about by the pursuit of the "ideal body type," which cannot be ignored. This study aims to explore the relationship between body image construction and mental health among college students. This study utilized data from the Survey on Physical Activity and Mental Health of College Students. A total of 1,192 students were randomly selected as the survey sample, and 1,044 valid samples were obtained. The mean age of the respondents was 19.34 years.

Methods: First, we categorized body image constructs into three categories based on the differences between subjective and objective body image: high acceptance, low acceptance, and consistency. Second, to ensure analytical rigor and minimize potential confounders, we used a generalized propensity score weighting model. Finally, we used a causal mediation framework to investigate the potential causal mechanisms between the independent variable (perceived body image bias) and the dependent variable (mental health) in order to better understand the "net effect."

Results: (1) There is a significant correlation between college students' body image perceptual bias and mental health, i.e., the higher the individual's acceptance of his/her own body image, the higher the level of mental health, and vice versa. (2) Students in humanities and social sciences are more likely to have increased psychological burden due to poor negative body image. (3) In the mediation analysis, although the causal mediating effect of physical exercise was not significant, family and peer support in physical exercise played an important mediating role, especially the influence of peers was more significant.

Conclusion: The construction of body image is a double-edged sword that can either promote positive individual development or lead to self-depreciation. Creating a positive climate for physical activity has a positive impact on college students' mental health compared to participation in physical activity behaviors. While improving students' media literacy on college campuses, it is important to enhance adaptive guidance to promote their physical and mental health and personal development.

KEYWORDS

body image, physical exercise, psychological health, social support, college student

Introduction

In China, an intriguing phenomenon has emerged among college students, manifesting in their various online "photo-sharing" activities that have left netizens astounded, proclaiming that "going to college is akin to undergoing plastic surgery." The stark contrast between their initial "outdated" appearance upon entering college and their subsequent "fashionable" transformation upon graduation has sparked fervent discussions and inspired countless imitations among internet users. As the notion that "good looks and figure equate to justice" becomes the guiding principle for constructing body image, college students' approach to body management increasingly leans toward external evaluations. This includes the widespread dissemination of a series of body image ideals, notably the pursuit of an "ideally thin" physique, which resonates deeply within the college student community. A survey conducted in China revealed that nearly 70% of college students have engaged in weight loss behaviors in their pursuit of a satisfactory body shape (1). However, as the definition of a "satisfactory body shape" undergoes changes, their actions may also undergo transformations.

In response to this phenomenon, scholars have conducted a series of studies, yielding two contrasting conclusions. Scholars adopting a negative attitude argue that as college students excessively pursue weight loss and an ideal body shape, their satisfaction with their own body image experiences a downward trajectory, acting as a catalyst for "psychological weight gain" and resulting in adverse effects on mental health (2, 3). Beneath the surface of these unrealistic weight loss efforts lies the irrational convergence of body image construction, potentially harboring more negative factors (4). Furthermore, the pursuit of an ideal body shape has led to the proliferation of unhealthy methods of body shaping among young people. These detrimental practices have become a sort of "magic potion" for young individuals, enticing them with the illusion of swiftly attaining their desired physique (5). Conversely, scholars with a positive outlook approach the issue from the vantage point of symbolic interactionism, perceiving the body as a "symbolic medium." They contend that the pursuit of an ideal body shape can facilitate individuals' integration into higher social circles and grant them access to a wider array of external resources. They maintain that the process of striving for an ideal body shape represents a positive state of being, generating uplifting psychological stimuli and fostering the expansion of one's social networks when met with external affirmation (6–8).

The exploration of the relationship between body image construction and mental health levels in college students has become a pressing issue that warrants in-depth investigation. In today's modern society, the process of shaping body image is intricately intertwined within various micro-level social interactions, and it is far from being static. Individuals experience significant variations in social comparisons and psychological changes across different environments. Moreover, within the same environment, disparities in family resources and the subsequent development of information-gathering abilities greatly shape the differentiated process of body image construction. As a highly educated segment of society, college students aspire to align themselves with societal trends in order to enhance their overall self-image and information acquisition quality, especially in our fast-paced society (9). Simultaneously, as they progress in their personal development, they become more attuned to the vast array of information available, leading to heightened

sensitivity toward body image. Therefore, it is crucial to explore how college students perceive their own bodies and the subsequent impact of body image on their mental well-being. This study aims to investigate the cognitive biases in body image perception among college students, utilizing a survey conducted on the physical and mental well-being of Chinese college students. Through this analysis, we aim to shed light on the influence of body image on their mental health levels and provide practical recommendations.

Literature review and research hypotheses

The concept of "body image" was first introduced by Paul Schilder in the 1920s, and it has since become a critical area of study. Schilder defined body image as an individual's perception of their physical and psychological attributes, as well as their attitudes toward their own body characteristics (10). However, body image is not simply a matter of objective body shape; it is a multidimensional concept that encompasses perception, emotion, cognition, and behavior (11). In the process of constructing body image, individuals are often influenced by external evaluations. Chinese scholar Hong Chen describes body image as a psychological portrayal of an individual's body, including their cognitive understanding, attitudes toward physical and psychological functions, and the impact on their behavior (12, 13). Body image is subjective, transitioning from external evaluations to individual actions, and it also involves emotional evaluation (11, 14). What sets college students apart from other youth groups is their ability and willingness to take proactive measures in shaping their body image. They actively link their body image with their personal emotions and gradually integrate it into their self-concept. Moreover, the relatively open campus environment and the desire to conform to societal trends make having a desirable body shape a central aspect of college students' self-perception (9, 15).

With the emergence of consumer culture and liberalism on college campuses, the plasticity of the body undergoes changes as self-perception evolves, leading to a more stable body shaping (16, 17). This stable body shaping includes college students' self-perception of their own bodies, which serves as a vital conduit between the "self" and the external world (18). However, social comparisons in different contexts can result in cognitive biases. The external environment's influence on body image interacts closely with self-perception, ultimately alleviating the distress caused by societal pressures through the fulfillment of self-body image (2, 19). Xin et al. found that the micro-system environment of college, while providing some insulation from external pressures and reducing pre-existing disparities, highlights the value of self-body perception as individuals integrate into the college micro-social environment (13, 20). From the outset, they strive to cultivate a positive body image, translating their knowledge into action to shape their ideal physique—a promising beginning for college students (4, 12, 21). In the open campus environment, college students' body image construction reflects their psychological adjustment. However, it is important to be cautious of body image influenced by cultural norms. External influences continuously mold individuals, leading to a partial loss of self-image awareness (5, 13). In other words, the impact of the external environment on college students becomes increasingly subtle, resulting in cognitive biases in body image perception and a relatively

stringent body ideal (15, 22, 23). As such, college students' self-perception of their bodies holds particular significance for their mental well-being (3).

In today's society, both in the physical world and online, the visible presence of obesity plays a significant role in shaping one's self-image. However, obesity is not merely a physical state; it has become laden with social connotations. Consumer institutions cleverly exploit the plasticity and malleability of the body, using body-centric marketing to reshape people's perceptions of obesity and transcend its superficial implications. This external construction of the obese image not only places immense pressure on individuals but also fosters a demanding body image environment, prompting individuals to distance themselves from the negative associations of obesity and sometimes resorting to unhealthy weight loss strategies. Moreover, obesity is stigmatized, becoming a symbol of societal discrimination and prejudice. Shockingly, studies reveal that 65% of overweight and obese adults and 77% of overweight adolescents are subjected to negative and derogatory portrayals, with some even being depicted as intellectually inferior or lacking self-control (5). This stigma extends beyond individuals to educational institutions, where 28% of teachers consider obesity to be the worst thing that can happen to a person, and even parents may inadvertently provide less support to overweight children (24). In the digital age, the negative impact of obesity on body image is further exacerbated, hindering meaningful social interactions and perpetuating the stigmatization of those affected (15, 24). Consequently, obesity has become a primary target of body image "shaming," with widespread dissemination of derogatory portrayals. Obese individuals constantly face distorted body perceptions, the judgment of others, discrimination, and the burden of societal stigma, all of which erode their sense of bodily autonomy and self-worth (8, 24, 25).

Even when their weight is within the normal range, more than 60% of women choose to engage in weight loss efforts (26, 27). Research suggests that as the consumer culture surrounding the body becomes increasingly prevalent, women willingly conform to external evaluations in order to enhance their life opportunities, thereby reinforcing these evaluations in the process. This strong desire for body shaping leads college students to unilaterally pursue an ideal body shape, often resorting to unhealthy weight loss methods in their pursuit of thinness as the epitome of beauty (26, 27). When individuals are influenced by distorted body perceptions in their external environment, they further reinforce negative body image perceptions in social interactions (16, 28, 29). Negative body image perceptions become the primary trigger for body shape anxiety among college students, to the extent that deviations in body image perceptions lead to significant self-deprecation regarding their own body image (30). The cognitive habits associated with negative body image also have a profound impact on self-esteem and tendencies toward unhealthy weight loss, serving as a psychological inertia that deepens college students' dissatisfaction with their bodies. If college students hold preconceived misconceptions, it will inevitably lead to increased anxiety and unease in their college lives (25). However, from another perspective, college students with a higher level of body image acceptance are more likely to alleviate body shape anxiety. For instance, research indicates that within the college campus, the prevalence of diverse cultures weakens the one-sided "thinness as beauty" body image construction, thereby reducing the likelihood of individuals experiencing body shape anxiety (27). Based on these findings, this study proposes hypothesis 1.

> *H1*: Lower body image acceptance will have a negative impact on the mental health of college students. Conversely, higher body image acceptance will have a positive effect on mental health.

It is noteworthy that prior studies have aimed to investigate the influence of body image perception distortions on mental health by considering social divisions and structural heterogeneity, including factors such as gender, class, and even regional disparities (1, 2, 10, 22). While significant interventions from external environments have been observed, these structural factors often emerge naturally, disregarding the potential impact of individual choices. Professional choices, for college students, are not only personal decisions but also comprehensive selections influenced by various conditions, including familial and societal relationships, thereby being subject to diverse structural factors. Consequently, for college students, professional choices replace structural differences, becoming more nuanced and multifaceted forms of heterogeneity. For instance, research has revealed that students in STEM fields appear to have lower self-imposed body image standards, whereas those pursuing humanities and social sciences exhibit relatively positive attitudes (31–33). Within the college student population, the division of majors holds significant representativeness. Building upon these insights, hypothesis 1a is proposed:

> *H1a*: There are professional differences in the relationship between body image cognitive biases and mental health levels.

Bourdieu posits that body image construction is a pivotal factor in attaining status and differentiation, serving as a pathway to acquiring bodily capital (6). This process has often been simplified as "perception-action-outcome" in previous studies. While college students come from diverse backgrounds, once they step foot on the university campus, their lives undergo a transformation, presenting a relatively uniform living experience. The previous academic competition is diminished, making room for new forms of competition. Notably, the construction of a body image that aligns with the university culture becomes an integral aspect. Drawing on existing research, physical exercise emerges as a key element in shaping body image (34, 35). It not only serves as a tool for self-transformation but also as a means of showcasing and obtaining symbolic value (36–38). This study specifically focuses on the impact of body image perception distortions on mental health, with physical exercise being the primary avenue for body management. It not only translates natural bodily symbols into discernible symbolic orders but also gives rise to biased body expectations (6). Consequently, physical exercise not only positively influences body image construction but also significantly contributes to promoting psychological well-being. In fact, it is even recognized as an adjunct therapeutic approach for mental health conditions. As body image construction influences physical exercise, it subsequently generates positive effects on mental health (11, 19, 35). Thus, we propose the following hypothesis.

> *H2*: Physical exercise has a mediating effect on the relationship between body image construction and mental health levels.

In addition, the construction of body image is a complex interplay of both objective and subjective factors, representing individuals' perception and development of body value within the realm of body management (36, 39). Body capital holds significant value for individuals in their social interactions and facilitates the transition of capital types. The relationship between body perception and the external environment is robust, with social capital exerting substantial influence on the construction of body image (40, 41). Consequently, the construction of body image becomes a process through which individuals transition from body capital to other forms of capital. However, this process is influenced by individual tastes, habits, and social positions, leading to diverse impacts. Moreover, the social comparison of body image brings about changes in social capital, which, in turn, affects the mechanism of "body image-mental health." Notably, the influence stemming from social capital also significantly impacts psychological well-being. Based on these insights, we propose hypothesis 3: the influence of the sports atmosphere.

> *H3*: Social support has a mediating effect on the relationship between body image and mental health.

Data sources

This survey employed online methods such as WeChat and utilized random sampling. It was conducted in September 2021 in the provinces of Shaanxi, Hunan, and Gansu. The survey targeted undergraduate students (first, second, third, and fourth year) and some graduate students from Xi'an Jiaotong University, Xi'an University of Electronic Science and Technology, Shaanxi Normal University, Xi'an University of Technology, Xi'an Technological University, Tianshui Normal University, and Huaihua College. The selected sample covers a wide range of school categories and majors, including universities involved in the "985 Project," "211 Project," local key universities, and regular undergraduate institutions. The majors include science and engineering, economics and management, humanities, agriculture, medicine, law, and foreign languages, among others. The sample structure of the survey is reasonably balanced. The survey collected information on students' individual characteristics, physical activities, mental and physical health, and social interactions. A total of 1,200 questionnaires were distributed, with 1,192 returned. Ultimately, 1,044 valid questionnaires were obtained, resulting in an effective response rate of 87%.

Variable selection

Dependent variable

The dependent variable in this study is the level of mental health among college students. We used the Center for Epidemiologic Studies Depression Scale (CES-D) to measure the level of mental health. To ensure rigor, internal consistency and validity of the questionnaire were tested during the revision process.

First, we examined the reliability of the survey data using Cronbach's alpha coefficient, which resulted in $0.88 > 0.7$, indicating high reliability. The Kaiser-Meyer-Olkin (KMO) measure was used to assess the validity of the questionnaire, and the result was $0.899 > 0.80$. Additionally, the Bartlett's sphericity test ($X2 = 80.66$, $p < 0.05$) confirmed good structural validity of the questionnaire.

The questionnaire covers 10 questions related to the frequency of experiences in the past 2 weeks, such as "frequency of loss of interest or pleasure in activities," "frequency of feeling down, depressed, or hopeless," "frequency of difficulty sleeping, waking up, or excessive sleepiness," "frequency of feeling tired or having little energy," "frequency of poor appetite or overeating," "frequency of feeling dissatisfied with oneself," "frequency of difficulty concentrating," "frequency of moving or speaking slowly or being restless," "frequency of thoughts of death or self-harm," and so on. These questions are measured on a Likert scale ranging from 1 to 5. We reverse code and sum the responses from low to high intensity, resulting in a mental health score ranging from 0 to 100. A higher score indicates a higher level of mental health.

Independent variable

This study focuses on the cognitive bias of body image among college students. This variable is composed of subjective perception of obesity and objective body shape. Subjective overweight refers to a situation where the objective body shape is thin, but the subjective perception is overweight, indicating a lower acceptance of body image. Subjective underweight refers to a situation where the objective body shape is overweight, but the subjective perception is underweight, indicating a higher acceptance of body image. The difference between subjective and objective body image is the cognitive bias of body image.

I in the specific operation, BMI is used as the operational variable to measure the objective body shape, following the BMI indicators for Chinese adults. This classification is primarily based on the recommendations of the Working Group on Obesity in China (WGOC) (42). BMI < 18.5 is categorized as "underweight" and assigned a value of 1; $18.5 \leq BMI \leq 23.9$ is categorized as "normal" and assigned a value of 2; $BMI \geq 24$ is categorized as "overweight" and assigned a value of 3.

Second, in order to understand individuals' subjective perception of their bodies, we used the question "How do you perceive your own body shape?" for measurement. The scale originated from the Chinese General Social Survey (CGSS). To better align with the actual experiences of college students and facilitate their responses, we modified the CGSS question "How do you perceive your current physical health status?" to "How do you perceive your current body shape?" The response options are coded as follows: 1 = "very thin," 2 = "a bit thin," 3 = "neither fat nor thin," 4 = "a bit fat," 5 = "very fat." Similarly, the responses are recoded as follows: "very thin" and "a bit thin" are categorized as underweight and assigned a value of 1, "neither fat nor thin" is categorized as normal and assigned a value of 2, "a bit fat" and "very fat" are categorized as overweight and assigned a value of 3.

Finally, a contingency table is used for analysis. The samples in the lower left part of the diagonal in the contingency table indicate higher acceptance of body image and are assigned a value of 1; the samples on the diagonal indicate cognitive consistency and are assigned a value of 2; the samples in the upper right part of the diagonal indicate lower acceptance and are assigned a value of 3.

Mediating variables (physical activity)

Physical activity (PA) is one of the mediating variables in this study. PA is measured using the International Physical Activity Questionnaire (IPAQ) (short form). The questionnaire consists of 7 questions designed to assess physical activity levels based on categories of walking, moderate, and high-intensity activities. During the data processing, the outliers and truncation principles of the questionnaire are strictly followed, as well as the weights assigned to different intensities of physical activity, to calculate the energy expenditure value (MET) for each student's PA. MET is used to reflect the level of physical activity among college students, with higher numerical values indicating higher intensity of physical activity. The duration and frequency of reported exercise are also taken into account.

To align the MET variable with a normal distribution, a natural logarithm transformation is used to create a continuous variable that follows a normal distribution. Additionally, to further enhance the mediating effect of physical activity, the three continuous variables are categorized as high, medium, and low, forming three groups of continuous variables.

Mediating variables (social support)

One of the mediating variables in this study is social support. Drawing from Berkman and Cantor's categorization of social support (33), social support for college students is divided into two aspects: family support and peer support. In this questionnaire, we utilized the following questions: "My father or male family members encourage me to participate in sports," "My father or male family members provide guidance for my physical exercises," "My father or male family members provide material support for my physical exercises," "My father or male family members provide technical support for my physical exercises," "My mother or female family members encourage me to participate in sports," "My mother or female family members provide guidance or encouragement for my physical exercises," "My mother or female family members provide material support for my physical exercises," "My mother or female family members provide technical support for my physical exercises." These questions were scored on a scale of 1 to 5, ranging from "never" to "always." In the data analysis process, these scores were summed to create a continuous variable, ranging from 0 to 40, with higher scores indicating stronger family support.

Similarly, we utilized the same set of questions, replacing "father" or "mother" with "peers" or "classmates." These questions also generated a continuous variable ranging from 0 to 40.

Control variables

This study includes 7 variables: gender, age, grade level, school type, household registration, family socioeconomic status, and self-rated health status. Gender is coded as female = 1, male = 0. School type is categorized as national key university = 3, provincial key university = 2, provincial regular university = 1. Household registration is coded as rural = 0, urban = 1. Family socioeconomic status is categorized as lower = 1, lower-middle = 2, middle = 3,

upper-middle = 4, upper = 5. Self-rated health is rated as very poor = 1, poor = 2, fair = 3, good = 4, very good = 5. Additionally, we have included the square of age.

Analysis strategy

To accurately investigate the relationship between virtual body image and levels of psychological well-being, it is essential to address the potential issue of selection bias between the two. Selection bias arises when individuals have different probabilities of entering different processing levels (21). Previous research has shown that distorted body image perception may be associated with various factors, and these confounding variables can also impact levels of psychological well-being. For example, individuals who frequently use electronic devices are more likely to experience distorted body image perception, and the use of electronic devices itself can have an influence on psychological well-being (42). Therefore, simply comparing the levels of psychological well-being among groups with different perceptual biases makes it challenging to determine whether the observed differences are due to body image perception or the distinct characteristics of these groups with different body image perceptions. The interference of these confounding variables makes it difficult to observe the "net effect" of body image perception bias on levels of psychological well-being. To establish a more compelling causal relationship between virtual body image and psychological well-being, it is necessary to control for these confounding factors in research.

The focus of this study is on the perception of body image, which is categorized into three groups. To ensure the validity of our research, we employ a generalized propensity score weighting approach. This method, as suggested by Guo and Fraser (17), involves incorporating confounding variables into a multinomial logistic regression model to calculate the generalized propensity scores for each individual. These scores are then used to determine individual weights, allowing us to represent the broader population accurately. Following the adjustment for basic sociodemographic characteristics, we utilize a weighted logistic regression model to examine the relationship between educational attainment and levels of general trust.

In our analysis, we aim to focus exclusively on the net effects, employing a causal mediation analysis framework to investigate the causal relationship between the independent and dependent variables. Causal mediation analysis operates within a counterfactual framework, allowing us to capture statistically significant causal relationships (21). Furthermore, this approach offers flexibility in terms of the types of mediator and outcome variables considered, accommodating both continuous and categorical mediators and outcomes. It also accommodates multi-category treatment variables, making it applicable to our study's multi-category treatment variable—acceptance of overweight body image. Additionally, when examining the mediation effect of a specific mediator variable, we include other mediator variables in the model predicting the outcome variable. This control helps to mitigate the influence of other mediator pathways, preventing confounding and interference from other mediator factors, and enables us to examine the net effect of the mediator variable.

Results

Descriptive statistics

Filling in the missing values was done using multiple imputation, as shown in Table 1. Descriptive statistics revealed the following: (1) The average level of psychological health among students in the humanities and social sciences is lower than students in other STEM majors. (2) Among students in the humanities and social sciences, the proportion of those with lower body image acceptance is 22.84%, while the proportion of those with higher body acceptance is 11.20%. In non-humanities and social sciences students, this proportion has changed, with the proportion of those with lower body image acceptance decreasing to 16.90% and the proportion of those with higher body acceptance increasing to 14.95%. Preliminary findings suggest a certain connection between body image perception bias and psychological health. Comparatively, humanities and social science majors have stricter requirements for their body image, with a much higher proportion of students having lower body acceptance compared to other majors. This may be related to the nature of the majors. Research has shown that students choosing humanities and social science majors tend to have a more subjective and intuitive cognition, while STEM students tend to be more objective.

In addition, Table 2 demonstrates the effects of body image differences on mental health and the effects of heterogeneous outcomes across disciplinary majors. In Model 2, the coefficient of disciplinary majors is significantly positive, indicating that students majoring in non-humanities and social sciences have higher levels of mental health. In Model 3, the regression coefficients remained significantly positive when the interaction term between body image differences and disciplinary specialization was added, indicating a positive moderating effect of disciplinary specialization on the effects of body image differences on mental health. Specifically, students in humanities and social sciences are more likely to have increased psychological burden due to poor negative body image, thus validating the hypothesis of H1a.

Generalized propensity score estimation and weighted processing

Table 3 presents the results of the multinomial logistic regression model predicting the generalized propensity scores. Among the findings, students with higher socioeconomic status and higher grade levels have higher body image requirements, while rural students have a lower probability of being satisfied with their body image. As age increases, college students' level of non-acceptance of their own body image shows a U-shaped trend, with a decrease followed by an increase. Since we are not specifically interested in the effects of specific confounding variables, we will not provide specific interpretations of the regression coefficients here.

To suppress the occurrence of covariate imbalance in the matching process, we adopted a weighted approach. The results show that after weighted processing, the distribution of covariates between the treatment and control groups is generally balanced. The propensity score weighting method largely eliminates the covariate imbalance and corrects for selection bias.

After obtaining the propensity scores, we can explore the net effects of body image perception on mental health levels using a generalized weighted approach, according to the analytical strategy. Table 3 presents the regression results after weighted adjustment. Compared to college students with unbiased body image perception,

TABLE 1 Factor analysis of items of health.

Variable	Entire sample			Humanities and social sciences major		Non-humanities and social sciences major		p
	N (%)	Mean	Range	N (%)	Mean	N (%)	Mean	
Mental health	1,044	76.26	0–100	482	75.56	562	79.80	0.542
Low-intensity exercise	999	6.07	Logarithm	463	6.11	536	6.04	0.032
High-intensity exercise	885	5.80	Logarithm	376	5.91	509	5.72	0.000
Total physical Activity	992	4.32	Logarithm	450	4.03	542	4.67	0.000
Family status	1,044	2.42	1–5	482	2.46	562	2.40	0.000
Parental education	1,044	12.02	6–19	482	11.76	562	12.24	0.000
Grade	1,044	1.82	1–7	482	2.32	562	1.40	0.004
Age	1,044	19.34	17–45	482	20.01	562	18.76	0.253
Body image	1,044	1.56	1–3	482	1.49	562	1.61	0.029
Low acceptance	234 (22.41)			139 (28.8)		95 (16.9)		
Consistency	672 (64.37)			289 (59.9)		383 (68.1)		
High acceptance	138 (13.22)			54 (11.2)		84 (14.9)		
Family support	1,044	19.06	0–40	482	19.39	562	18.76	0.000
Peer Support	1,044	17.07	0–40	482	17.05	562	17.09	0.000

TABLE 2 The impact of cognitive bias on mental health.

	Model 1	Model 2	Model 3
High acceptance		7.808*** (1.41)	8.521*** (1.66)
Low acceptance		−7.567*** (2.26)	−8.563*** (2.42)
Professional category		4.677*** (1.21)	2.524** (2.95)
Physical cognitive bias * professional category			1.392* (1.77)
Control variable	Controlled	Controlled	Controlled
N	1,044	1,044	1,044

*$p < 0.1$, **$p < 0.05$ (standard errors in parentheses).

TABLE 3 Multinomial logistic regression results predicting individual body image acceptance propensity scores.

	High acceptance VS consistency	Low acceptance VS consistency
Urban and rural (rural = 0)	−0.271* (0.16)	0.233 (0.28)
Age	0.312 (0.33)	−0.875** (0.35)
Age squared	−0.010 (0.01)	0.014** (0.01)
Family economic status	0.180* (0.10)	−0.373** (0.17)
Number of children	−0.124 (0.15)	0.227 (0.26)
Type of school	−0.263** (0.12)	−0.007 (0.20)
Type of major (Social Science = 0)	0.113 (0.17)	0.085 (0.26)
Gender (male = 0)	0.259 (0.16)	−0.420* (0.25)
Grade	0.245** (0.10)	0.062 (0.18)
Constant terms	−1.937 (3.77)	10.835** (4.72)
Sample size	1,041	

*$p < 0.1$, **$p < 0.05$ (standard errors in parentheses).

those who are dissatisfied and have difficulty accepting their own bodies are more likely to experience negative effects on their mental health. On the other hand, college students with higher body satisfaction tend to have a positive impact on their mental health levels. The average difference in mental health levels between individuals who accept or do not accept their body image is 10.49. Additionally, through robust estimation, the results remain stable, indicating that individuals with unbiased body perception have an average mental health level of 74.22. After adjusting with generalized propensity score weighting, the impact of body perception on mental health levels increases, suggesting that some confounding factors may have interfered with the relationship between body image perception and mental health levels. The use of propensity score weighting is meaningful.

Mediation analysis

Table 4 reports the causal mediation effects of different levels of exercise intensity energy expenditure on the relationship between body image perception and mental health levels. The top half of the table presents the linear regression results predicting the mediation variables using the dependent variable, body image perception, for low-intensity, moderate-intensity, and high-intensity exercise expenditure.

Individuals with lower levels of self-body image acceptance are more likely to engage in moderate to high-intensity physical exercise, while the effect is not significant for low-intensity exercise. Conversely, individuals with higher levels of self-body image acceptance are more inclined to participate in low-intensity physical exercise. In other words, individuals with lower body image acceptance are more willing to engage in moderate to high-intensity physical exercise, while relaxation of body management and willingness to exercise are not prominent, even if they do exercise, they prefer low-intensity workouts. The columns representing the expected outcome variables show the mediation effects of different types of physical exercise on mental health levels, predicted by body image perception, while controlling for all other mediator variables.

The results of the causal mediation analysis also indicate that the impact of body image perception on college students' mental health levels is primarily a direct effect (ADE), with limited mediation effects through physical exercise. However, college students with stricter body management still have a certain proportion of improvement in mental health levels through moderate to high-intensity physical exercise (Table 5).

Table 6 reports the mediation effects of family support and peer support in the relationship between body image and mental health levels. The table presents the mediation effects of family support and peer support on the relationship between body image perception and mental health levels. The results show that, after controlling for other mediator variables and control variables, both family support and peer support have significant mediation effects.

Table 7 presents the causal mediation effects. It can be observed that a supportive exercise environment can influence individuals who are part of it, even if they are not directly involved in the exercise. For college students with different levels of self-body image acceptance, the proportion of mediation effects from family support is 11.72%, and for those with different levels of non-acceptance, it is 10.41%. The mediation effects from peer support are 12.15% for acceptance and 13.23% for non-acceptance of body image. This also suggests that, after entering college, a supportive exercise environment is more likely to impact individuals' mental health levels, and having family resources that support exercise helps mitigate external influences and improve mental health levels.

Discussion

Body image plays a pivotal role in comprehensive sex education, and guiding and helping college students to construct a positive body image is of great practical significance to their healthy physical and mental development. This paper classifies the construction of college students' body image from both objective and subjective levels, and in doing so, explores the relationship between body image cognitive bias and mental health, as well as the potential mechanisms that may exist. The following conclusions were drawn: (1) Through the weighted analysis of the propensity values in Table 8, it was found that college students' deviation from reality and pursuit of extreme body image

TABLE 4 Causal mediation analysis of the effects of body image perception on psychological well-being (Part 1).

	Low intensity		Medium intensity		High intensity	
	Predict mediation variables	Predictor outcome variables	Predict mediation variables	Predictor outcome variables	Predict mediation variables	Predictor outcome variables
Reference group (unbiased)						
High	129.386*	3.731***	30.180	3.731***	70.110	3.731***
Low	−48.468	−4.727*	−194.828***	−4.727*	619.279***	−4.727*
Mediation		<0.001		0.005		0.002
Other mediation		YES		YES		YES
Control variables		YES		YES		YES
Intercept	1024.28	97.92***	−951.740	97.92***	1024.280	97.92***
Sample size	1,041					

$p < 0.1$, **$p < 0.05$, ***$p < 0.01$ (standard errors in parentheses).

TABLE 5 Causal mediation analysis of the effects of body image perception on psychological well-being (Part 2).

Causal mediation effect	High VS consistency	Low VS consistency	Higher VS consistency	Low VS consistency	Higher VS consistency	Low VS consistency
ACME	0.057	0.059	0.132	0.33	0.166	0.44
ADE	5.54	7.83	5.47	7.55	5.44	7.44
Total effect	5.6	7.89	5.61	7.89	5.61	7.89
Proportion of mediation effect	1.02%	0.76%	2.3%	4.1%	2.9%	5.6%

(1) The computation results for the evaluation parameters of the mediating effects were obtained through 1,000 iterations of the quasi-Bayesian Monte Carlo approximation simulation. (2) The "Proportion of Mediation Effect" reported in the table is calculated by dividing the "Average Causal Mediation Effect" (ACME) by the "Total Effect." The numerical values may have slight differences compared to the results obtained from calculating ACME and total effect directly in the table. This discrepancy is due to the decrease in numerical precision caused by rounding.

would have a more serious negative impact on their mental health. On the contrary, having a more positive attitude toward their body image would have a positive impact on their mental health. At the same time, more demanding body image constructs had a greater negative impact on mental health levels. This finding was subsequently confirmed indirectly in Tables 4, 6. (2) In the moderated effects model in Table 2, we found that students majoring in humanities and social sciences were more sensitive to their body image compared to students majoring in other categories. (3) Through Tables 5, 7, we found that while the causal mediating effect through physical activity was not significant, family and peer support for physical activity played an important mediating role, and the influence of peers in particular was more significant.

Specifically, Conclusion 1 demonstrates that the distorted construction of body image is a major factor influencing the psychological well-being of university students. This finding aligns with the majority of research conducted in Western societies (7, 11, 24). However, the model construction and explanatory paths in this study differ from previous approaches. Existing studies based on samples from Western countries have predominantly approached the topic from either a psychological or sociological perspective, highlighting distinct differences. The psychological perspective represents an endogenous viewpoint, focusing on subjective body image as the unit of analysis and examining historical, societal, and cultural factors as facets of psychological influences. For example, Cash argues that body image is a multidimensional psychological experience that extends beyond mere appearance (43). On the other

hand, the sociological perspective reflects an exogenous viewpoint, considering body image as part of social interactions and its associations with factors such as race, skin color, and regional boundaries. For instance, Bourdieu views the body as a form of "bodily capital" shaped by external environments (6), while Goffman suggests that the body is a tool for social interactions (44). The key distinction between them lies in Bourdieu's perspective, where bodily capital is determined by an individual's external circumstances, while Goffman believes that body image is subject to change as social interactions evolve. These studies often attempt to examine subjective or objective aspects of body construction, relying on a stable social context.

However, we believe that this fixed or single path of interpretation may be more applicable to European and American societies and not to China. The reason for this is that China has changed dramatically over the past 40 years of reform and opening up, while European and American societies are relatively stable. Chinese universities, for example, are becoming more and more open and diversified, with both "universities without walls" and "universities at will" existing in the schools we surveyed, and the population of Chinese universities becoming richer and richer, with the student body having changed from the initial "university without walls" to "university at will." The student body has evolved from an "elite" to a "public." Therefore, it is difficult to examine the real situation of Chinese university students from a single dimension in such an open and changing external environment. Therefore, we attempted to construct new variables of subjective body image (psychological factors) and objective body

image (social factors) to further clarify the relationship between college students' perceived body image bias and mental health. Based on this, the explanation we give for the first result comes from two aspects.

Based on this, we offer two explanations for the first result. Firstly, the cultural aspect. In China, "fat" and "thin" are the primary factors in assessing body image. In university campuses, being "ideally thin" represents a desirable physique. This contrasts sharply with Western societies. For instance, Stanford University and others have found that Western cultural influences shape the perception of body image, with many males aspiring to a "muscular" physique as their ideal and believing that females prefer muscular men (45). The pursuit of muscularity leads to higher levels of physical exercise participation among Western university students compared to those in mainland China. Secondly, the cognitive aspect. The rise of consumer culture has provided various body techniques for shaping the image of being overweight. University students in China do not need to engage in physically demanding activities that require significant time and effort to shape their bodies; instead, they can rely on clothing, appearance, and balanced diets as relatively flexible and effortless means to achieve their desired body image. This differs significantly from the emphasis on muscularity in Western campuses. In short, Chinese university students prioritize "looking thin" rather than "being healthy thin." This viewpoint is indirectly supported by a survey conducted by China Youth Network in 2021. The survey revealed that with the increasing

openness of Chinese university campuses and the accelerated dissemination of body-related information through the internet, university students have become one of the main consumer groups in the realm of body image. Among those students attempting weight loss, 62.45% do not have good exercise habits (1), making their weight loss endeavors more likely to falter.

Furthermore, our research on professional heterogeneity has also been validated. Despite the limitation of sample size, we categorized the professions into two major groups and observed that the differences among professions significantly moderate the impact of body image distortion on psychological well-being. Previous studies conducted in China have suggested that different professions possess distinct knowledge systems, which consequently contribute to diverse constructions of body image (46). Moreover, further investigation revealed that humanities and social science majors amplify the negative psychological levels associated with low body image acceptance. We believe that this conclusion may also be attributed to the strong job orientation of university majors in China. For students in humanities and social sciences, their work primarily involves complex social contexts. Therefore, cultivating a body image that aligns with current trends would facilitate their professional endeavors.

Finally, the underlying mechanisms differ from previous studies. In prior research, physical exercise was believed to exert positive effects, whereas in our study, this mechanism was replaced by the social support derived from physical exercise. Many previous studies touted physical exercise as a panacea, and various investigations on mental health emphasized the importance of physical exercise. However, they overlooked the fact that physical exercise actions often require alignment with good exercise habits (45), which in turn necessitate inclusive social support as a safeguard. We believe that the lack of significant mediating effects of physical exercise in our study is related to the absence of good exercise habits and an exercise-friendly atmosphere among Chinese university students. We attempt to provide two explanations: firstly, the parents of Chinese university students are products of an era of relative material scarcity, and with the improvement in material conditions, they have placed more emphasis on improving living standards in their offspring's investment, rather than considering physical exercise as a priority (30). Secondly, Chinese students face intense academic competition and perceive physical exercise as a hindrance to studying, with long-term guarantees being lacking (36). Consequently, the lack of a conducive exercise environment makes it difficult for university students to develop exercise habits. This aligns with what we observed in the mediating effects, where physical exercise did not emerge as an underlying mechanism,

TABLE 6 Causal mediation analysis of the effects of body image perception on psychological well-being (Part 3).

	Family support		Peer support	
	Predict mediation variables	Predictor outcome variables	Predict mediation variables	Predictor outcome variables
Reference group (unbiased)				
High	1.906***	3.731***	2.025***	3.731***
Low	−1.707*	−4.727*	−2.903***	−4.727*
mediation		0.199***		0.123*
Other mediation		YES		YES
Intercept	−7.465***	96.867***	−1.895***	96.867***
Sample size	1,041			

*$p < 0.1$, ***$p < 0.01$ (standard errors in parentheses).

TABLE 7 Causal mediation analysis of the effects of body image perception on psychological well-being (Part 4).

Causal mediation effect	High VS consistency	Low VS consistency	High VS consistency	Low VS consistency
ACME	0.66***	0.82***	0.68***	1.04***
ADE	4.96***	0.76***	4.93***	6.83***
Total effect	5.61***	7.88***	5.62***	7.88***
Proportion of mediation effect	11.72%	10.41%	12.15%	13.23%

(1) The computation results for the evaluation parameters of the mediating effects were obtained through 1,000 iterations of the quasi-Bayesian Monte Carlo approximation simulation. (2) The "Proportion of Mediation Effect" reported in the table is calculated by dividing the "Average Causal Mediation Effect" (ACME) by the "Total Effect." The numerical values may have slight differences compared to the results obtained from calculating ACME and total effect directly in the table. This discrepancy is due to the decrease in numerical precision caused by rounding.

TABLE 8 Weighted propensity analysis of the predictive effect of college students' body image on psychological well-being.

Variables	Before weighting	After weighting
Reference group (unbiased): 74.22		
Low acceptance	−5.234** (2.21)	−5.974*** (2.29)
High acceptance	4.395*** (1.19)	4.514*** (1.19)
Control variables	YES	YES
Constant terms	95.072*** (23.07)	82.538* (44.09)
R2	0.075	0.113
Sample size	1,041	

$**p < 0.05$, $***p < 0.01$ (standard errors in parentheses).

which also corresponds to the current research conducted by Chinese scholars. For instance, Chinese scholars utilizing data from surveys conducted between 1985 and 2005 found that Chinese university students increasingly rejected the idea of an overweight body shape, while simultaneously experiencing varying degrees of decline in their physical fitness (47).

The limitations of this study stem mainly from the average effects produced by quantitative research. On one hand, the lack of support from longitudinal data makes it difficult to observe the changing trends in college students' body image construction. On the other hand, the absence of corresponding interviews hinders further verification of the reliability of the conclusions.

Conclusion

Based on the above conclusions, this paper argues that the construction of body image and mental health level of college students can not only rely on schools and students, but also need the whole society to create a "healthy and beautiful" standard. Secondly, we should strengthen the educational norms to guide college students to build a healthy and positive body image. Educational institutions can provide relevant health education programs to help students develop correct body image concepts, and provide more appropriate guidance and support based on professional differences. Second, media literacy education should be strengthened to enhance college students' ability to recognize media content and reflect on it. College students should learn to rationally assess the body image presented in the media and establish positive values and evaluation standards. Finally, school education should emphasize its guiding role and actively guide students to form correct health and esthetic views. Physical exercise can be an effective intervention to help improve the mental health of college students who have cognitive biases in body

image. Through these measures, we can promote the physical and mental health of college students and help them better adapt to social life and personal development.

Data availability statement

The datasets presented in this article are not readily available because for academic research only. Requests to access the datasets should be directed to niulong@xatu.edu.cn.

Author contributions

XW: Conceptualization, Data curation, Writing – original draft. CL: Formal analysis, Writing – review & editing. LN: Conceptualization, Writing – review & 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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Does depression affect the association between prosocial behavior and anxiety? A cross-sectional study of students in China

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Background: A growing number of studies have suggested that adolescents' prosocial behavior can protect against depression and anxiety. It is known that anxiety and depression are often comorbid. However, it remains unclear if when depression is present, prosocial behavior remains protective against anxiety, and if when anxiety is present, prosocial behavior remains protective against depression. The purpose of this study was to determine the association of anxiety and depressive with prosocial behavior.

Methods: A large representative sample of middle-school students was recruited for a cross-sectional study and completed standardized instruments (the Children's Depression Inventory (CDI), Screen for Child Anxiety Related Emotional Disorders–Child version (SCARED-C), and Strengths and Difficulties Questionnaire (SDQ)). We used structural equation modeling (SEM) to examine the protective effect of prosocial behavior against anxiety when depression was present.

Results: A survey of 3,510 students was conducted, and the final analysis included 3,169 students, comprising 1,616 boys (51.0%) and 1,553 girls (49.0%), with a mean age of 13.09 years (SD = 1.31, range 11–16).The prevalence rates of anxiety and depression in early adolescents were 31.6 and 16.7%, respectively. More than two-thirds of depressed adolescents had comorbid anxiety, while more than one-third of anxious adolescents had comorbid depression. Regression models showed that compared with depressed adolescents, adolescents without depressive symptoms exhibited a significant negative correlation between prosocial behaviors and anxiety and depression ($\beta = -0.01$, $p > 0.01$, $\beta = -0.06$, $p > 0.01$; $\beta = -0.11$, $p < 0.01$, and $\beta = -0.17$, $p < 0.01$). There was no difference in the relationship between prosocial behavior and depression between anxious and non-anxious adolescents ($p > 0.05$).

Conclusion: Anxiety and depression are common in adolescence and are often comorbid disorders. However, the comorbidity is not symmetrical. Specifically, the protective effect of prosocial behavior against anxiety is weaker in depressed adolescents. Findings are discussed in light of related research and theory, and insights for intervention programs and future research are presented.

1. Introduction

The prevalence rates of mental health problems have increased among adolescents worldwide, as high as 20.0% (1, 2). If left untreated, they tend to persist into adulthood and are associated with a range of adverse outcomes (3). Mental health problems account for 16% of the disease and injury burden among adolescents aged 10–19 years worldwide, according to statistics released by WHO in 2019. Thus, promoting mental health among adolescents is a public health priority (4).

Anxiety and depression are the most prevalent mental health problems in adolescence. Nearly 40% of adolescents reported having experienced anxiety symptoms, and 8.3% qualified for severe anxiety-related impairment (5). Anxiety is the sixth leading cause of disease and disability for adolescents aged 11–14 years and the ninth leading cause for those aged 15–19 years (6). A meta-analysis indicated that the prevalence of depressive symptoms in adolescents was18.4% before 2000 and was 26.3% after 2016 in China (7). More than half of adolescents who commit suicide may have had a depressive disorder at the time of death (8), and depression in adolescents is a primary risk factor for suicide (8). The high prevalence of anxiety and depression in adolescents and the high rates of disability require a focus on adolescent anxiety and depression.

Anxiety and depression often co-occur (9, 10). Diagnostic comorbidity rates reported in some clinical samples were as high as 75% (11, 12). Approximately 25–50% of depressed youth have anxiety, and approximately 10–15% of anxious youth have comorbid depression (13). Depressed youths with comorbid anxiety tend to have more severe depressive symptoms than no anxious depressed youths (13). Thus, the symptoms may be magnified in children and adolescents with comorbidities (13). However, individuals with a comorbid disorder also exhibit some unique characteristics. One study found that depressed youths tended to report high levels of depression and anxiety, while anxious youths tended to report relatively low levels of depression (14). Comorbidity may result in greater overall impairment, higher rates of suicide attempts and worse treatment outcomes (15, 16). A better understanding of the relationship between anxiety and depression is crucial for preventing comorbidities and mitigating their impact in depressed/anxious adolescents. Anxiety and depression share various risk and protective factors (17), individually, they might not exert the same level of influence on outcomes. Exploring risk and protective factors and determining their effects are important to prevent anxiety and depression in adolescents.

Prosocial behavior, often referred to as sociability, is a complex amalgamation of different types of social interactions (18). Prosocial behaviors are intended to benefit others, including helping, caring, cooperating, sharing, sympathizing and comforting (19). Recent meta-analyzes indicated that prosocial activities have a positive effect on well-being and reduce negative emotions. Prosocial behavior is socially respected, and the social rewards it accrues may, consequently, improve mood (20). Conversely, prosocial behavior may protect against negative feelings (21), depression and anxiety (22, 23). These studies have not considered the high rates of comorbidity observed. However, epidemiological studies suggest that comorbidity is universal, not exceptional; therefore, solely exploring the association of prosocial behaviors with a single mental health problem may not be comprehensive. It is essential to determine the association of depression and anxiety with prosocial behaviors in adolescents to elucidate internalizing problems in adolescents as well as to implement more optimal interventions for anxiety and depression. The present study aimed to investigate (a) the association between prosocial behavior and anxiety when depression was present, and (b) the association between prosocial behavior and depression when anxiety was present.

2. Methods

2.1. Subjects and procedure

This cross-sectional study used a stratified random cluster sampling method to recruit students from junior high schools in the Pudong New Area, Shanghai, China, from September to November 2021. A total of 3,510 participants aged 11–16 years took part in the survey. After excluding the data of participants with invalid questionnaires, 3,169 participants were included in the final analysis, for a response rate of 90.3%.

2.2. Ethical approval

Approval for the study was obtained from the Ethics Committee of Shanghai Pudong New Area Mental Health Center. The parents of all participants provided informed consent to participate in the study (PDJWLL2021030).

2.3. Measures

2.3.1. Sociodemographic variables

A custom-designed demographic questionnaire was used to collect the participants' general information, including age, gender, monthly family income, marital relationship of parents (harmony/disharmony), family structure (nuclear family/extended family/other family structures), parenting style (consistent/inconsistent) and relationship with friends (good/acceptable/bad). Family economic status was categorized into three classes according to monthly family income: lower (less than ¥5,000), middle (¥5,000–10,000), and upper (more than ¥10,000).

2.3.2. Depressive symptoms

Depressive symptoms were assessed using the Children's Depression Inventory (CDI), which consists of 27 items. The CDI is a comprehensive multilayer assessment of depressive symptoms in children and adolescents and has five subscales: negative mood, interpersonal problems, ineffectiveness, anhedonia and negative self-esteem (24, 25). Participants were asked to indicate the presence of 27 problems in the last 2 weeks on a 3-point scale ranging from 0 (none) to 2 (distinct symptom). Higher scores indicate more depressive symptoms. In this study, participants with a cutoff score of 19 or higher were considered to have significant depressive symptoms. The CDI has good internal consistency, with Cronbach's alpha coefficients ranging from 0.71 to 0.89 (26). The reliability and validity of this test

in the Chinese population have been demonstrated (27). The Cronbach's alpha coefficient of the CDI was good (0.88) in the present study.

2.3.3. Anxiety symptoms

Anxiety symptoms were assessed using the Screen for Child Anxiety Related Emotional Disorders–Child version (SCARED-C), which measures 41 symptoms. Participants are asked how often they had been bothered by each symptom over the previous 3 months. The response options are "almost never," "sometimes," and "often," scored as 0, 1 and 2, respectively. The SCARED-C includes five subscales: generalized anxiety symptoms, separation anxiety symptoms, social anxiety symptoms, panic or somatic symptoms, and school avoidance (28, 29). A total score of 25 or more has been recommended to indicate significant clinical anxiety (30, 31). Good retesting reliability and validity for the SCARED-C have been confirmed in the Chinese population (32). The Cronbach's alpha coefficient of this questionnaire was 0.84 in the present study.

2.3.4. Prosocial behavior

Prosocial behavior was assessed using the prosocial scale of the Strengths and Difficulties Questionnaire (SDQ), which is a 25-item checklist (33). The SDQ is divided into five scales of five items each: conduct problems, emotional problems, hyperactivity, peer problems, and prosocial behavior (34). The prosocial scale assesses adolescents' prosocial behavior. Items are rated on a 3-point Likert scale ranging from 0 to 2 (0 = never, 1 = sometimes, 2 = always). Higher scores indicate more prosocial behavior (35). There are three versions of this questionnaire: the parent version, the teacher version and the self-report version (36), and the self-report version was used in this study. The Chinese version of the SDQ has been demonstrated to have good reliability and validity in Chinese adolescents (37). The internal consistency of the prosocial behavior score (Cronbach's alpha = 0.70) in the present study was sufficient.

2.4. Statistical analysis

Descriptive and inferential statistics were calculated using SPSS version 25.0 for Windows (SPSS, Inc., Chicago, IL, United States). AMOS24 (IBM Corporation, Armonk, NY, United States) was used for correlation analysis and regression analysis. Categorical variables are described as frequencies and percentages and were compared using the chi-square test. The internal consistency of the CDI, SCARED-C and the prosocial scale was evaluated using Cronbach's alpha values. Pearson correlation analyzes were used to analyze relationships between study variables. A p value <0.05 was considered statistically significant, and all statistical tests were two-sided.

Structural equation modeling (SEM) was used to examine the relationships of latent variables. Model fit was evaluated using the chi-square test (χ^2/df), root mean square error of approximation (RSMEA), comparative fit index (CFI), incremental fit index (IFI) and Tucker–Lewis index (TLI). Notably, χ^2/df > 2 implies good model fit; RSMEA values <0.05 represent close model fit, and values >0.10 reflect poor model fit (38); and CFI, IFI, and TLI values >0.90 indicate good fit (39). The fit indices should be interpreted collectively. Standardized coefficients (β) were examined with regression path analyzes.

3. Results

3.1. Demographic characteristics of subjects

A survey of 3,510 students was conducted, and a total of 3,169 (90.3%) students were included in the final analysis. The sample consisted of 1,616 (51.0%) boys and 1,553 (49.0%) girls, with a mean age of 13.09 years (SD = 1.31, range 11–16). Descriptive statistics for all categorical variables are shown in Table 1. Most participants were from nuclear families (61.0%), had middle or upper family economic status (86.2%), maintained good relationships with their friends (62.1%), reported that their parents had a "good" relationship (88.5%), and reported experiencing a consistent parenting style (70.9%).

3.2. Prevalence and comorbidity rates of anxiety and depression among middle school students

The prevalence rates of anxiety and depression among middle school students were 31.6 and 16.7%, respectively. Boys had a lower prevalence of anxiety than girls ($p < 0.05$) but a similar prevalence of depression ($p > 0.05$). The prevalence rates of anxiety and depression were higher in participants from nuclear families than in those from large families and other types of families, and there were significant differences among family types ($\chi^2 = 7.80$, $p = 0.020$; $\chi^2 = 7.85$, $p = 0.020$). We found no significant difference in other variables ($p > 0.05$). More than two-thirds of students who met the threshold for depression as a primary condition also had anxiety symptoms, while more than one-third of students who met the threshold for anxiety as a primary condition also had depressive symptoms. The comorbidity rate of anxiety and depression was 11.8% among adolescents. See Table 1 for more details.

3.3. Correlations between study variables

Table 2 summarized the correlations found between study variables with means and standard deviations for all continuous study variables. Prosocial behavior was negatively associated with anxiety, depression and SDQ-Externalized Problems ($r = -0.177$, $p < 0.001$; $r = -0.359$, $p < 0.001$; $r = -0.392$, $p < 0.001$). SDQ-Externalized Problems was positively associated with anxiety and depression ($r = -0.452$, $p < 0.001$; $r = -0.615$, $p < 0.001$). Anxiety was positively associated with depression ($r = -0.589$, $p < 0.001$).

3.4. Effects of prosocial behavior on anxiety in individuals with depression and on depression in individuals with anxiety

The results showed that the overall model fit was acceptable (χ^2/df = 7.754, RSMEA = 0.046, CFI = 0.990, IFI = 0.990, TLI = 0.964). The regression model showed that the correlations between adolescents' externalizing problems and anxiety were significantly positive ($\beta = -0.34$, $p < 0.001$). As shown in Figure 1, among 2,639 middle

TABLE 1 Distribution of variables, and association with anxiety and depression among middle school students.

Variables	Total N = 3,169		Depression			Anxiety		
	n	(%)	n	(%)	Value of p	n	(%)	Value of p
Sex								
Male	1,616	(51.0)	268	(16.6)	0.829	436	(27.0)	0.000
Female	1,553	(49.0)	262	(16.9)		564	(36.3)	
Marital relationship of parents								
Harmony	2,803	(88.5)	478	(17.1)	0.181	876	(31.3)	0.310
Disharmony	366	(11.5)	52	(14.2)		124	(33.9)	
Family structure								
Nuclear family	1933	(61.0)	349	(18.1)	0.020	643	(33.3)	0.020
Extended family	955	(30.1)	133	(13.9)		283	(29.6)	
Other family structures	281	(8.9)	48	(17.1)		74	(26.3)	
Family economic situation								
Upper	1,126	(35.5)	200	(17.8)	0.444	366	(32.5)	0.335
Middle	1,606	(50.7)	263	(16.4)		488	(30.4)	
Lower	437	(13.8)	67	(15.3)		146	(33.4)	
Parenting style								
Consistent	2,247	(70.9)	377	(16.8)	0.917	698	(31.1)	0.355
Inconsistent	922	(29.1)	153	(16.6)		302	(32.8)	
Relationship with friends								
Good	1967	(62.1)	336	(17.1)	0.757	605	(30.8)	0.406
Okay	649	(20.5)	103	(15.9)		209	(32.2)	
Bad	553	(17.4)	91	(16.5)		186	(33.6)	
Depression	530	(16.7)	530	(100.0)		375	(70.8)	
Anxiety	1,000	(31.6)	375	(37.5)		1,000	(100.0)	
Both anxiety and depression	375	(11.8)	375	(100.0)		375	(100.0)	

TABLE 2 Bivariate correlations between and descriptive statistics for all continuous study variables (r value).

Variables	1	2	3	4
1.PB	–			
2.Anxiety	−0.177**	–		
3.Depression	−0.359**	0.589**	–	
4.SDQ-Externalized Problems	−0.392**	0.452**	0.615**	–
Mean	7.90	18.26	11.10	4.73
(SD)	(2.11)	(13.65)	(7.66)	(3.31)

PB, Prosocial behavior, **$p < 0.001$.

school students without depressive symptoms, there was a significant negative correlation between prosocial behavior and anxiety ($\beta = -0.11$, $p < 0.01$), and prosocial behavior significantly negatively predicted the depressive symptom scores of middle school students ($\beta = -0.17$, $p < 0.01$). As shown in Figure 2, among the 530 middle school students with depressive symptoms, the correlation between prosocial behavior and anxiety was not statistically significant ($\beta = -0.01$, $p > 0.01$), and prosocial behavior did not significantly predict depressive symptoms in adolescents ($\beta = -0.06$, $p > 0.01$). As

shown in Figures 1, 2, compared with adolescents without depression symptoms, adolescents with depressive symptoms did not exhibit a protective effect of prosocial behavior. While there was a significant negative correlation between prosocial behavior and anxiety symptoms among adolescents without depressive symptoms, this correlation was absent among adolescents with depressive symptoms. As shown in Figures 3, 4, there was no difference in the protective effect of prosocial behavior against depression between anxious and no anxious adolescents ($p > 0.05$).

4. Discussions

We found that anxiety and depression were prevalent among adolescents, with prevalence rates of 31.6 and 16.7%, respectively. Adolescence is a high-risk period for the onset of mood disorders, particularly anxiety and depression (40). Adolescence is a period of upheaval and change in physical, cognitive, emotional and social factors (41). During this period, adolescents face many developmental challenges, such as the need for academic achievement, peer relationships and independence from parents (42). Female adolescents are more likely than males to suffer from mood and anxiety disorders (43). Similar to previous studies, our findings confirmed that there
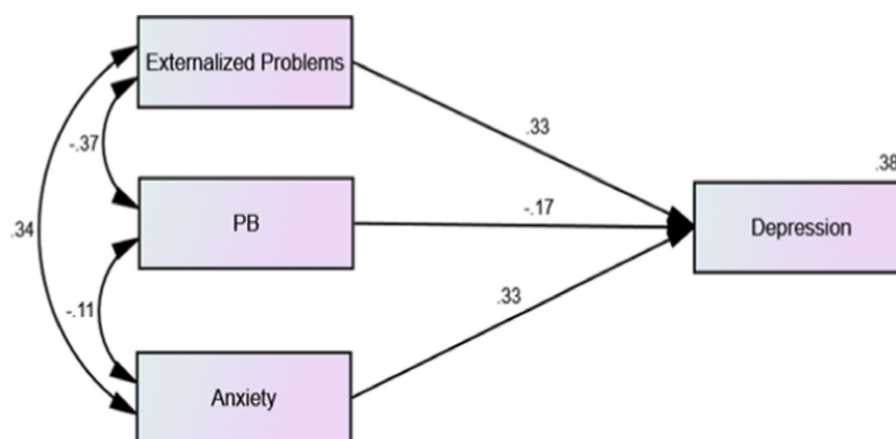
FIGURE 1
Regression model of external problems, prosocial behavior, anxiety and depression factors of middle school students without depressive symptoms.
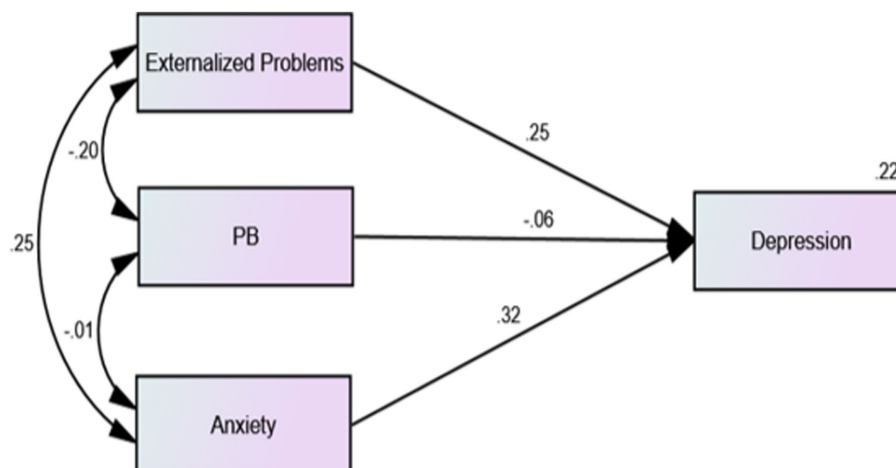

FIGURE 2
Regression model of external problems, prosocial behavior, anxiety and depression factors of middle school students with depressive symptoms.

was a gender difference in the distribution of anxiety, with female adolescents having a higher prevalence of anxiety than male adolescents. However, we did not find a gender difference in the incidence of depression. Previous research has suggested that female adolescents are biased toward depressive symptoms due to gender differences in hormone levels during puberty (44, 45). The gender difference in depression is one of the strongest findings in psychopathology research (46). Considerable empirical and theoretical research has been conducted on gender differences in depression. However, the findings have been inconsistent. One study found that male adolescents have a higher risk of depression than female adolescents (47). There may be a gender-age pattern of depressive symptoms. Several studies have shown that during childhood, boys are more likely than girls to suffer from depression (48). The increased prevalence of depression in females is thought to occur between the ages of 13 and 15 years (49, 50). The age range of our study sample was 11 to 16 years. Differences in the age range of samples may have contributed to the inconsistent results regarding gender differences in

adolescent depression. In addition to age, differences in other nonphysical factors, such as research instruments, cultures, regions, and social structure, may also be important factors leading to inconsistent findings and a comprehensive meta-analysis of gender differences in adolescent depression could be conducted in the future. We also noted that living in extended families may protect adolescents' emotional health compared to living in nuclear families. One possible explanation is that adolescents in nuclear families receive less emotional support than those in extended families, as these children can draw upon grandparents as additional (or alternative) sources of attachment, reassurance and knowledge and possibly experience decreased parental stress (51).

On the other hand, anxiety and depression are highly concurrent or sequential comorbidities. In some clinical samples, the correlation between dimensional measures of anxiety and depression symptoms was high (52), and the rate of diagnostic comorbidity was as high as 75% (11), with substantial comorbidity evident in both areas. We also found considerable levels of comorbid anxiety and depression in this
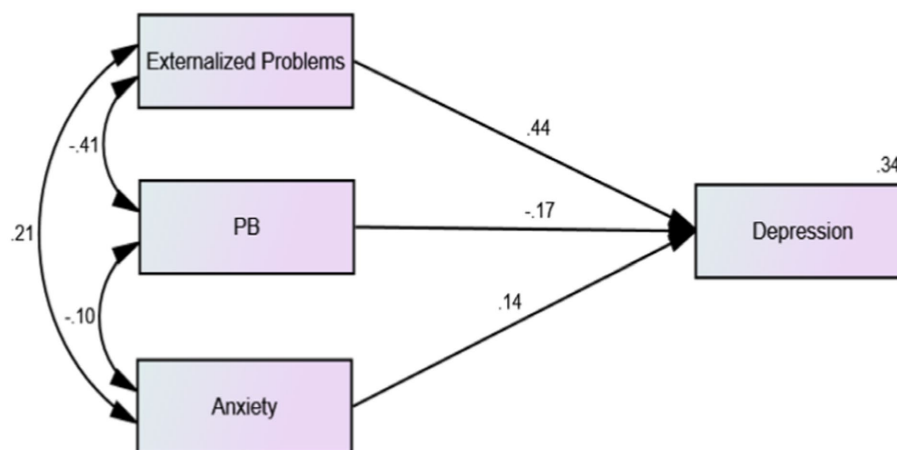
FIGURE 3
Regression model of external problems, prosocial behaviors, anxiety and depression factors of middle school students without anxiety symptoms.
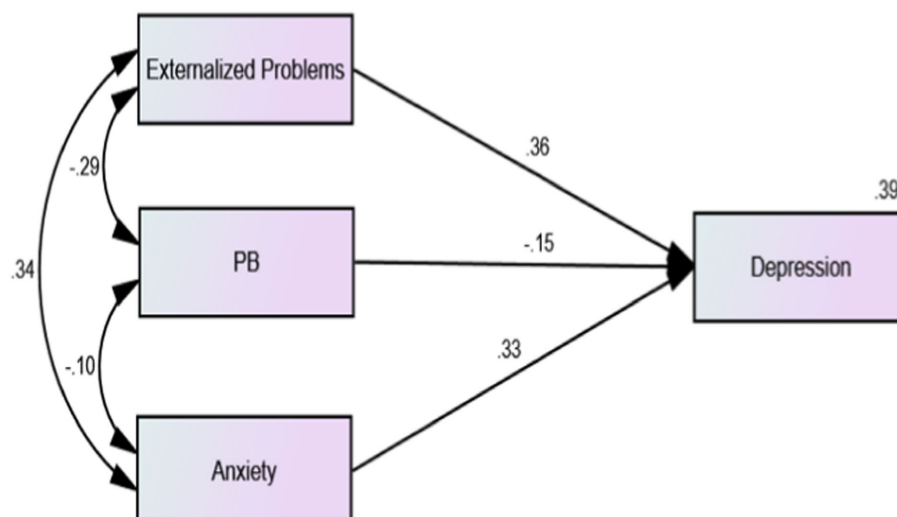
FIGURE 4
Regression model of external problems, prosocial behaviors, anxiety and depression factors of middle school students with anxiety symptoms.

large representative sample of Chinese adolescents. However, the comorbidity was commonly asymmetrical. That is, adolescents with a primary diagnosis of depression tended to have comorbid anxiety more often than adolescents with a primary diagnosis of anxiety experienced comorbid depression (13). This phenomenon was also confirmed in this study.

Most importantly, we analyzed the association between prosocial behavior and internalizing problems such as anxiety and depression. Our findings indicated that higher levels of prosocial behavior were associated with lower levels of anxiety and lower levels of depression. Specifically, prosocial behavior was negatively associated with anxiety and depression, consistent with some previous research (21–23), suggesting that prosocial behavior may prevent anxiety and depression. Prosocial behaviors are positive and friendly voluntary behaviors that an individual displays toward others. It is quite common during adolescence because during this period, opportunities for prosocial behaviors increase. Adolescents are especially sensitive to the quality

and type of interactions they have with people in their social networks, and poor interpersonal interactions can lead to unfavorable mental health outcomes such as anxiety and depression (53). Previous research has shown that children who display high levels of prosocial behavior receive positive feedback and peer acceptance from their peers, and being liked and accepted by peers is associated with increased self-confidence and reduced anxiety and depression in children (54). Thus, prosocial behavior is important for forming and maintaining healthy relationships, and it can protect adolescents from maladjustment. Engaging in prosocial behaviors, especially with strangers, also promotes or stimulates the development of dominant personalities, which is especially important in early adolescence, as adolescents are developing character strengths that may continue to play a protective role in late adolescence and adulthood (55). In addition, according to response transformation theory, engaging in prosocial behaviors facilitates psychological adaptation through shifts in internal norms, values, and concepts of well-being as well as disengagement from

self-focused psychological problems, such as anxiety and depression (56, 57). Prosocial behaviors, such as volunteering, leadership, and civic engagement, have often been incorporated into positive adolescent interventions, both as desired outcomes and as protective factors against future negative outcomes (58). All of the above findings suggest that adding prosocial behavior programs in schools may be beneficial. One school-based intervention study showed that when prosocial behavior was structurally added to the students' curriculum, students' mood level was significantly improved (59).

It is notable that the protective effect of prosocial behaviors against anxiety and depression may occur in both healthy and anxious adolescent populations. In further analyzes, we found that the protection of prosocial behavior against anxiety disappeared in individuals with depressive symptoms, but prosocial behavior still protected against depression in individuals with anxiety symptoms. Depression may have a greater impact on adolescents' prosocial behaviors; they become more introverted, withdrawn and unable to exhibit warmth, compassion and helpfulness to others, resulting in decreased prosocial behavior. Individuals with low levels of prosocial behavior will experience more interpersonal problems and stress, making it difficult for them to stop negative self-thoughts and reflection and even aggravate these issues (60). This in turn increases the risk of depression and anxiety, resulting in a vicious cycle. Thus, treating depressive symptoms may be the first step for adolescents with depressive symptoms (e.g., through counseling interventions or medication). Alleviating the depressive symptoms of adolescents may help to restore the sensitivity provided by prosocial behavior and benefit from it.

Although our results indicated that prosocial behavior was negatively associated with depression and anxiety, these findings need to be verified in the future, especially in other adolescent samples. Inconsistent results have been reported in previous studies, particularly regarding the association between prosocial behavior and adolescent anxiety. For example, there is evidence that high levels of prosocial behavior protects against anxiety in girls (61). However, a recent meta-analysis showed that prosocial behavior was not related to anxiety (62). Another study showed that normative levels of anxiety were positively associated with prosocial behavior (63). In the future, research should focus on the association between prosocial behavior and adolescents' internalizing problems from a more specific and multidimensional perspective.

5. Limitations

Our study has two potential limitations. First, it had a cross-sectional design; therefore, we could not dynamically analyze the association between prosocial behaviors and internalizing problems. Second, all measures in the study were self-reported, potentially leading to shared method bias. Although adolescents were considered the best reporters of their internal states (such as anxiety and depression), future research should investigate a wider range of reporters (e.g., parents, teachers).

6. Conclusion

Anxiety and depression are common in adolescents and are often comorbid. Adolescents spend more time in school than in any other

formal institutional institution. Therefore, schools play a key role in the development of adolescents in all aspects. For adolescents without depressive symptoms, adding prosocial behavior to educational goals may be beneficial for their emotional management. Increasing school support and cultivating adolescents' self-esteem and hope can promote prosocial behavior. However, in adolescents who already have depressive symptoms, increasing prosocial behavior may not be the most effective method. Instead, depressive symptoms may first need to be structurally addressed.

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 Committees of Shanghai Pudong New Area Mental Health Center. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

Author contributions

XZ: Writing – original draft, Funding acquisition. TL: Data curation, Writing – original draft. GL: Methodology, Investigation, Software, Writing – review & editing. NZ: Investigation, Writing – original draft. XL: Formal analysis, Writing – original draft. YL: Software, Writing – original draft. YC: Writing – review & editing, Funding acquisition.

Funding

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 author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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Functions of nonsuicidal self-injurious behavior in Russian patients with suicidal ideation

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Introduction: Nonsuicidal self-injurious behavior (NSSI) is an important risk factor for future suicide attempts. Previous research has identified a number of motivations for engaging in NSSI. The aim of the present study was to translate the Inventory of Statements About Self-Injury (ISAS) into Russian and then to evaluate its psychometric properties in a sample of patients with non-psychotic mental disorders and suicidal ideation (SI). Other aims were to determine the prevalence of specific NSSI functions in this population and to assess the relationship between different NSSI functions and clinical and psychological parameters.

Participants and methods: The study was conducted at the largest center for non-psychotic mental disorders in Moscow. All admitted patients with both NSSI and SI completed the Russian version of the ISAS-II, underwent the Self-Injurious Thoughts and Behaviors Interview, and completed the Personality Inventory for DSM-5 and ICD-11 Brief Form Plus-Modified, the Beck Depression Inventory, and the State−Trait Anxiety Inventory.

Results: A total of 614 patients were included in the study. 543 (88.4%) patients were assigned female at birth with a mean age of 24.86 (7.86) years. Factor analysis supported a two-factor structure (Intrapersonal and Interpersonal) of the Russian version of the ISAS-II, but in contrast to the original study, the "Marking distress" function loaded more strongly on the Interpersonal factor. In people with non-psychotic mental disorders and SI, Interpersonal functions of NSSI are associated with more severe depressive symptoms ($r = 0.34$), 12 months history of NSSI ($r = 0.30$), higher number of NSSI methods ($r = 0.41$), likelihood of future NSSI ($r = 0.35$) and psychoticism ($r = 0.32$).

Conclusion: The Russian version of the ISAS-II is a valid and reliable instrument for assessing NSSI functions in a population at high risk for suicide attempts. Interpersonal functions are associated with a number of unpleasant clinical and psychological features.

1. Introduction

Suicide remains one of the leading causes of preventable death, particularly among young adults (1). The death rate from suicide has not shown a significant decline in recent decades (2), comparable to that observed for many other causes of premature death (3, 4). Despite the many studies carried out each year in this area, the problem remains unresolved and it is appropriate to continue the search for modified predictors of suicide.

Recent studies have identified nonsuicidal self-injury (NSSI) as a highly significant risk factor for future fatal and non-fatal suicide attempts (5–7). People with mental disorders who also have suicidal ideation and NSSI are clearly a group at highest risk of attempting suicide. At the same time NSSI is highly prevalent both in the general population (8) and particularly among people with mental disorders (9, 10) and only a minority of them attempt suicide. Therefore, research into the characteristics of NSSI that distinguish those at high risk of suicide is warranted. Over the last decade, the number of studies on NSSI has increased, but the data obtained vary considerably depending on the methods used by the authors (11, 12). A set of instruments that are freely accessible, available in many languages and validated in different countries is a prerequisite for conducting comprehensive comparative studies on NSSI and suicidal behavior.

To date, none of the self-report instruments used by researchers worldwide to assess parameters associated with NSSI (13) has been validated in the Russian language. The lack of a tool to assess the functioning of NSSI hinders progress in the development of appropriate suicide prevention programs in Russia. It's worth noting that suicide remains a major public health problem in the Russian Federation as the country's suicide mortality rate has exceeded the European average for several decades (14). These data contrast with the relatively small number of published papers on suicidal behavior (15), and very few of these have considered NSSI as a potential risk factor for suicidality (16–18). Among the many reasons for ignoring this very important issue, the lack of validated Russian-language instruments for NSSI studies may be one of the most important.

Another benefit of validating the instrument for assessing NSSI functions is the development of more precise treatment strategies for individuals with specific NSSI motives. For example, programs aimed at increasing emotional tolerance (e.g., Dialectical Behavior Therapy) may be recommended for patients for whom affect regulation is the dominant motive for NSSI, whereas programs aimed at improving communication skills and family therapy may be recommended for those for whom distress communication is the primary function (19–21).

The Inventory of Statements About Self-Injury (ISAS) (22, 23) is a freely available tool that provides information about NSSI parameters such as type of NSSI, age of onset, date of last NSSI, experience of physical pain, willingness to stop self-harm (ISAS-I), and key functions of NSSI (ISAS-II). The instrument has been validated in many languages including Serbian (24), Spanish (25), Hungarian (26), Persian (27), Korean (28), Turkish (29), Urdu (30), and Swedish (31), and is currently in active use worldwide. Most of the translated versions of this instrument showed good internal consistency and the 2-factor structure of the ISAS-II (intrapersonal and interpersonal factors), which is consistent

with the results of the original study. For example, in a Turkish study factor analysis of the functions scale confirmed the good fit of the original 2-dimensional model (RMSEA = 0.08 (0.07–0.09); CFI = 0.97; NFI = 0.97) (29). Cronbach's alpha was 0.92 for the Korean version of the ISAS-II, indicating excellent internal consistency reliability (28). The test–retest reliability of the instrument was also found to be good (32).

Previous studies that using the ISAS-II have found that certain NSSI motives are more strongly associated with various adverse outcomes than others. For example, Reinhardt et al. (33) found that intrapersonal, but not interpersonal NSSI functions were associated with indicators of NSSI severity (current and recurrent NSSI, versatility of methods). In addition, a number of psychopathological features (co-occurring mental disorders, presence of a mood disorder, internalizing symptoms of mental illness, and self-critical rumination) were associated with engagement in NSSI for intrapersonal reasons. Thus, studies using the ISAS to assess the functions of NSSI may provide insight into the place of different subtypes of NSSI within the psychopathological taxonomy.

However, even though the ISAS is not a diagnostic tool and does not require a cut-off point, the use of simply translated versions of the instrument without studying its psychometric properties (31, 34) should not be considered good practice. For example, even for instruments with fewer questions, inconsistencies in the factor structure between the original and Russian-language versions have been reported (35, 36). Moreover, in the Iranian study (37), the EFA showed a single-factor solution that provided an adequate fit in the subsequent confirmatory factor analysis (CFA). In addition, a Japanese study (38) reported a three-factor structure of the instrument: "Distress coping functions," "Interpersonal influence functions," and "Identity maintenance functions." Also, the study conducted in a Mexican student population (39) found 7 interpretable factors ("Self-regulation," "Revenge," "Sensation seeking/toughness," "Avoiding suicide," "Marking distress," "Self-determination and numbness"), 5 more than the original version of the ISAS-II. These data support the need for a psychometric study of the Russian version of the ISAS-II prior to its use.

The primary aim of the study was to translate the ISAS-II into Russian language and then to examine its psychometric properties in a sample of Russian-speaking patients with non-psychotic mental disorders and suicidal ideation. It seems crucial to understand the characteristics of the instrument in this special population, which is characterized by an enormously high risk of suicide attempts.

The next aims of the study were to obtain data on the prevalence of various NSSI functions in a consecutive sample of Russian patients with non-psychotic mental disorders and suicidal ideation, and to assess the relationship between various NSSI functions and clinical (diagnosis, depression and anxiety levels, self-harm thoughts and behaviors) and psychological (personality traits) characteristics.

Patients with primary psychotic disorders were not included in this study because we believe that a separate study of NSSI functions in these patients is warranted. This is because many key parameters for understanding these patients are not applicable to people with non-psychotic mental disorders (e.g., duration of untreated psychotic symptoms, impaired insight, and negative symptoms). Each of these parameters could potentially affect the motivation for NSSI, and we decided not to include people with primary psychotic disorders in the study.

2. Participants and methods

2.1. Procedure

The study was conducted at the Department of Suicide Research and Prevention at the Moscow Research and Clinical Center for Neuropsychiatry. The Center specializes in the treatment of patients with non-psychotic mental disorders. The study cohort is represented by patients with SI and NSSI aged >18 years and older, identified from a consecutive cohort of patients with non-psychotic mental disorders and suicidal ideation. Patients with primary psychotic disorders, current substance use disorders, cognitive deficits below the level of comprehension on self-report scales and interviewer questions were excluded from the study.

All patients are screened on admission for lifetime SI, suicide attempts (SA), and NSSI. The screening includes the first items in the relevant sections of the Self-Injurious Thoughts and Behaviors Interview (SITBI) – "Have you ever had thoughts of killing yourself?" "Have you ever actually made a plan to kill yourself?" and "Have you ever actually engaged in NSSI?" All patients are then seen by an experienced psychiatrist to confirm the diagnosis of a non-psychotic mental disorder according to ICD-10 criteria.

All eligible patients then completed the study questionnaires and were interviewed by the investigator to collect basic socio-demographic information and data on self-injurious thoughts and behaviors. The first patient was enrolled in January 2018 and the last in December 2019.

2.2. Measures

The Inventory of Statements about Self-Injury-II (ISAS-II) consists of 39 items with responses rated on a 3-point Likert scale from 0 (not relevant) to 3 (very relevant). The list of items begins with an opening statement: "When I self-harm, I am…" According to the authors of the original study, the ISAS-II has two higher-order functions (Interpersonal and Intrapersonal) and 13 lower-order facets. The Intrapersonal function in the original ISAS-II version consists of motives for NSSI such as "Affect regulation" (… releasing emotional pressure that has built up inside of me), "Anti-dissociation/feeling-generation" (… causing pain so I will stop feeling numb), "Anti-suicide" (… avoiding the impulse to attempt suicide), "Marking distress" (… creating a physical sign that I feel awful), "Self-punishment" (… punishing myself) and the Interpersonal function includes "Autonomy" (… demonstrating that I do not need to rely on others for help), "Interpersonal boundaries" (… demonstrating that I am separate from other people), "Interpersonal influence" (… letting others know the extent of my emotional pain), "Peer bonding" (… bonding with peers), "Revenge" (… getting back at someone), "Self-care" (… creating a physical injury that is easier to care for than my emotional distress), "Sensation seeking" (… doing something to generate excitement or exhilaration) and "Toughness" (… seeing if I can stand the pain). The Cronbach's alpha coefficient of the original ISAS-II version indicated good internal consistency for the interpersonal (0.88) and intrapersonal (0.80) factors (23).

With the permission of the author of the instrument (prof. ED Klonsky), the Russian version of the ISAS-II (Appendix 1) was developed using the back-translation method, which is recommended

as a first step in cross-cultural adaptation of instruments. The original version of the ISAS-II was translated from Russian by two native Russian psychiatrists, both of whom were fluent in English. The Russian version of the tool was then back-translated into English by another bilingual translator on the research team to confirm that the translation was consistent with the wording of the original scale. Finally, the Russian version was compared with the original version by an English-speaking consensus committee of clinicians. If there were discrepancies between the two versions, individual items underwent additional rounds of back-translation until they were deemed satisfactory. The developed version of the tool was tested on 16 patients with NSSI (8 females). In their feedback, none of the participants reported any difficulties in understanding the instructions for the tool or the meaning of the items. This version of the ISAS-II was later used in our study.

The Self-Injurious Thoughts and Behaviors Interview (SITBI) is a structured clinical diagnostic interview consisting of the following blocks: suicidal thoughts, suicide plans, suicide attempts, suicidal gestures, non-suicidal self-injurious thoughts and non-suicidal self-injurious behaviors (40). Each block contains up to 30 questions on prevalence, frequency, and contextual factors. The Russian version of the SITBI is mainly used for scientific purposes (17, 41), but in some clinical centers it is also used in routine clinical practice. For the purposes of this study, we used the SITBI questions on prevalence and age of onset of SI, SA, and NSSI, as well as items on methods of self-injury and questions assessing descriptive and contextual factors of NSSI.

The Personality Inventory for DSM-5 and ICD-11 Brief Form Plus-Modified (PID5BF + M) is part of the DSM-5 family of personality trait questionnaires (42, 43). The PID5BF + M was proposed by Bach et al. (44) and consists of 36 questions rated on a 4-point Likert scale from 0 (very untrue or often untrue) to 3 (very true or often true). The questionnaire assesses 6 domains, including 3 facets, each consisting of two questions: Negative Affectivity (emotional lability, anxiousness, and separation insecurity), Detachment (withdrawal, anhedonia, intimacy avoidance), Antagonism/Dissociality (manipulativeness, deceitfulness, grandiosity), Disinhibition (impulsivity, irresponsibility, distractibility), Anankastia (rigidity, perfectionism, and orderliness), and Psychoticism (unusual beliefs, perceptual dysregulation, eccentricity). The instrument showed good internal consistency (McDonald's omega coefficients ranged from 0.83 to 0.90) and its factor structure was fully consistent with the results of the study of the original version of the questionnaire (45).

The Beck's Depression Inventory (BDI) was developed to assess the severity of depressive symptoms (46). It consists of 21 items, each rated on a 4-point Likert scale from 0 to 3. The psychometric properties of the Russian version of the BDI have been previously evaluated, with Cronbach's alpha coefficients of 0.86 (47).

The State–Trait Anxiety Inventory (STAI) consists of two parts assessing state (STAI-S) and trait (STAI-T) anxiety (48). Each part contains 20 items and is scored on a 4-point Likert scale ranging from 1 (not at all) to 4 (very much so). The questionnaire has previously been validated in Russian by Khanin (49), with Cronbach's alpha of 0.89 and 0.85 for the state and trait anxiety modules, respectively (50).

2.3. Statistical analysis

Categorical variables are presented as frequencies (%) and continuous variables as arithmetic means (standard deviation).

Factor structure was assessed using exploratory factor analysis (EFA) with standard geomin (oblique) rotation and the weighted least square mean and variance adjusted (WLSMV) estimator. WLSMV is a robust estimator suitable for responses with four or fewer response categories and can be corrected for non-normality in the data set (51–53). Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity tests were used to assess the suitability of the data for EFA.

The internal consistency of the questionnaire was assessed using McDonald's omega scores (ω) (53). Average inter-item correlations of the NSSI functions were also calculated to assess item homogeneity (54).

Correlational analysis was used to assess the relationship between NSSI functions and sociodemographic and clinical variables. Correlations between inter/intrapersonal functions and binary variables (age, mental disorder diagnoses, lifetime and 12 months suicide attempts, and 12 months NSSI and NSSI medical treatment) were assessed using biserial correlations. Polyserial correlations were used to examine associations between NSSI functions and ordinal variables (SITBI items 153–162, 165–169) and Pearson's correlations for continuous variables.

Calculations were performed using Mplus v7.0, Jamovi v2.3.17.0 and BlueSky Statistics v10.3.0.

3. Results

3.1. Sample characteristics

Of the 3,644 patients screened, 655 (18.0%) were positive for lifetime SI and NSSI. Forty-one patients refused to participate in the study or completed the ISAS-II incorrectly. Thus, 614 patients were included in the final study calculation, of which 14 refused to undergo the SITBI but did not object to the use of their completed questionnaire data in the calculation. Data from these patients were therefore excluded from the analysis of the relationship between NSSI function and the SITBI variables.

Clinical and demographic variables are presented in Table 1. The majority of patients were assigned female at birth ($N = 543$; 88.4%) with a mean age of 24.86 (SD 7.86; range 18–72) years. Fifty-one patients (8.3%) had an alternative gender identity (those with a non-binary gender identity (e.g., gender fluid, agender, and bigender) and those receiving gender affirming care).

The most common diagnoses were affective disorders [bipolar disorder – 160 (26.1%); depressive disorder – 165 (26.9%)] and personality disorders [162 (26.4%)]. Fifty-five (9.0%) patients were diagnosed with more than one mental disorder. The lifetime prevalence of suicide attempts was 44.7%.

The mean age of onset of NSSI was 15.8 (6.4) years. Approximately 75% had engaged in NSSI in the past 12 months. The most common methods of NSSI were cutting or carving ($N = 457$; 75.7%), hitting ($N = 371$; 61.4%), biting ($N = 322$; 53.3%), and scratching ($N = 319$; 52.8%). The mean number of NSSI methods was 4.2 (2.0), and 77 (12%) of patients had previously sought non-psychiatric medical help for the consequences of NSSI.

3.2. Factor structure of the questionnaire

The EFA yielded a two-factor solution that accounted for 38.4% of the total variance. Factor 1 had an eigenvalue of 10.1 and

TABLE 1 Sociodemographic and clinical characteristics of the sample.

Parameter	Mean (SD)
Age	24.86 (7.86)
Age of onset of suicidal ideation	15.66 (6.45)
Age at first suicide attempt	18.1 (6.38)
Age at onset of NSSI	15.8 (6.4)
N of NSSI methods	4.2 (2.0)
BDI	30.81 (10.25)
STAI-S	61.48 (10.05)
STAI-T	62.07 (9.93)
PID5BF + M	
Negative affectivity	3.67 (1.4)
Detachment	2.31 (1.2)
Antagonism	2.16 (1.3)
Disinhibition	3.05 (1.28)
Anankastia	2.34 (1.54)
Psychoticism	2.35 (1.51)

Parameter	N (%)
Sex assigned at birth	
Male	71 (11.6%)
Female	543 (88.4%)
Gender	
Male	68 (11.1%)
Female	495 (80.6%)
Alternative gender identity	51 (8.3%)
Education level	
Elementary and middle school	32 (5.2%)
High school	102 (16.6%)
Secondary vocational education	85 (13.8)
Unfinished higher education	225 (36.6%)
Completed higher education	170 (27.7%)
Employment status	
Employed	379 (45.4%)
Retired	16 (2.6%)
Unemployed	319 (52.0%)
Marital status	
Single	343 (52.9%)
Married	69 (11.2%)
In another type of relationship (not formally married)	213 (34.7%)
Mental disorder diagnoses	
Schizophrenia spectrum disorder	77 (12.5%)
Bipolar disorder	160 (26.1%)
Major depressive disorder	165 (26.9%)
Anxiety disorder	79 (12.9%)
Obsessive-compulsive disorder	8 (1.3%)
Eating disorder	17 (2.8%)
Personality disorder	162 (26.4%)
Multiple psychiatric diagnoses	55 (9.0%)
Lifetime suicide attempts	270 (44.7%)
12-month suicide attempts	134 (22.2%)

(Continued)

TABLE 1 (Continued)

Parameter	N (%)
NSSI in the past 12 months	457 (75.7%)
NSSI methods	
Cutting or carving	457 (75.7%)
Hitting	371 (61.4%)
Pulling hair out	150 (24.8%)
Self-tattooing	50 (8.3%)
Picking a wound	276 (45.7%)
Burning skin	214 (35.4%)
Inserting objects under the nails or skin	70 (11.6%)
Biting	322 (53.3%)
Picking body areas	171 (28.3%)
Scraping skin	319 (52.8%)
Erasing skin	89 (14.7%)
Other	48 (7.9%)
Medical attention	72 (12.0%)

NSSI, nonsuicidal self-injury; SITBI, self-injurious thoughts and behaviors interview; BDI, Beck's depression inventory; STAI-S, state–trait anxiety inventory-sate; STAI-T, state–trait anxiety inventory-trait; PID5BF + M, personality inventory for DSM-5 and ICD-11 brief form plus–modified.

included Intrapersonal functions, and Factor 2 had an eigenvalue of 4.9 and included Interpersonal functions. The two factors had an intercorrelation of 0.22. As can be seen in Table 2, 34 of the 39 item loadings were consistent with the loadings reported by Klonsky and Glenn (23). Three items (11, 24, and 37) loaded on the Interpersonal rather than the Intrapersonal factor, and item 17 loaded on the Intrapersonal rather than the Interpersonal factor. Item 7 was cross-loaded on two factors, but both factor loadings were low (0.25). In order to maintain the integrity of functions such as "Sensation Seeking" and "Self-care," it was decided to place items 7, 17 in the original factors. Thus, Intrapersonal functions included functions such as "Affect regulation," "Self-punishment," "Anti-suicide" and "Anti-dissociation," and interpersonal functions – "Marking distress," "Self-care," "Interpersonal influence," "Toughness," "Sensation-seeking," "Interpersonal boundaries," "Autonomy," "Revenge" and "Peer bonding."

3.3. Internal consistency of the questionnaire

The McDonald's omega coefficient for the ISAS-II was 0.85, indicating good internal consistency. The internal consistency coefficients for the functions of the NSSI are presented in Table 3. McDonald's omega coefficients for Intrapersonal and Interpersonal functions were greater than 0.80. The internal consistency of most of the NSSI motives was acceptable ($\omega \geq 0.70$), except for the coefficients for "Self-Care," "Sensation seeking," "Interpersonal boundaries," and "Peer bonding," which ranged from 0.55 to 0.70, indicating less adequate reliability.

The average inter-item correlation coefficient for the ISAS-II was 1.51. As shown in Table 3, the average inter-item correlations for the

Interpersonal and Intrapersonal functions and most of the subfunctions were within the acceptable range of 0.15–0.50.

3.4. Prevalence of NSSI functions

As shown in Table 3, the most common functions of NSSI in non-psychotic patients with SI were "Affect regulation" ($N = 590$; 96.1%), "Self-punishment" ($N = 535$; 87.1%), "Marking distress" ($N = 484$; 78.8%), "Anti-suicide" ($N = 466$; 75.9%) and "Anti-dissociation" ($N = 446$; 72.6%). However, they rarely self-harmed for "Revenge" ($N = 119$; 19.4%) or "Peer bonding" ($N = 73$; 11.9%).

3.5. Factors related to the interpersonal and intrapersonal functions of NSSI

The results of the correlation analysis are presented in Table 4. A total of Intrapersonal self-injurious motives had significant positive weak correlations with and BDI score ($r = 0.34$) and negative significant weak correlations with age ($r = -0.39$). Significant weak positive correlations were found between Intrapersonal NSSI functions and psychoticism.

Intrapersonal NSSI functions were significantly positively correlated with 12 months history of NSSI ($r = 0.30$), number of NSSI methods ($r = 0.41$), automatic negative ($r = 0.49$) and positive reinforcement ($r = 0.50$), and likelihood of future NSSI ($r = 0.35$). Interpersonal functions had significant positive correlations with both negative ($r = 0.40$) and positive social reinforcement ($r = 0.42$).

4. Discussion

4.1. Sample characteristics

As the presence of NSSI and SI was assessed in all patients admitted to the inpatient unit, we were able to determine the prevalence of combined NSSI+SI in the hospital population of patients with non-psychotic mental disorders, which was 18.0%. Basic socio-demographic and clinical characteristics of the sample are shown in Table 1. The predominance of women in the sample is consistent with data on their greater use of psychiatric care. Recent study has found that over 76% of patients in the Moscow clinic for patients with non-psychotic mental disorders are women (55). On the other hand, the predominance of young people, those assigned female at birth and a significant proportion of participants with alternative gender identities is consistent with findings from studies conducted in other countries (56–58).

The distribution of diagnoses in the sample reflects the peculiarities of the organization of psychiatric services in the Russian Federation. In Russia, clinics treat patients with so-called non-psychotic mental disorders separately from patients with primary psychotic disorders, patients with mood disorders with psychotic features and patients with addictive or organic psychotic disorders. At the same time, patients with schizotypal and borderline personality disorders, even if they have transient psychotic symptoms, are

TABLE 2 Factor loadings of the ISAS-II items.

No.	Item	Intrapersonal	Interpersonal	Original function	Original factor
1	Calming myself down	**0.47**	−0.10	Affect regulation	Intrapersonal
2	Creating a boundary between myself and others	0.22	**0.45**	Interpersonal boundaries	Social
3	Punishing myself	**0.61**	0.03	Self-punishment	Intrapersonal
4	Giving myself a way to care for myself (by attending to the wound)	0.06	**0.40**	Self-care	Social
5	Causing pain so I will stop feeling numb	**0.81**	−0.12	Anti-dissociation	Intrapersonal
6	Avoiding the impulse to attempt suicide	**0.75**	0.07	Anti-suicide	Intrapersonal
7	Doing something to generate excitement or exhilaration	0.25	**0.25**	Sensation-seeking	Social
8	Bonding with peers	−0.32	**0.71**	Peer-bonding	Social
9	Letting others know the extent of my emotional pain	−0.06	**0.73**	Interpersonal influence	Social
10	Seeing if I can stand the pain	0.27	**0.46**	Toughness	Social
11	Creating a physical sign that I feel awful	0.20	**0.59**	Marking distress	Intrapersonal
12	Getting back at someone	−0.16	**0.79**	Revenge	Social
13	Ensuring that I am self-sufficient	0.18	**0.64**	Autonomy	Social
14	Releasing emotional pressure that has built up inside of me	**0.60**	−0.11	Affect regulation	Intrapersonal
15	Demonstrating that I am separate from other people	0.03	**0.70**	Interpersonal boundaries	Social
16	Expressing anger towards myself for being worthless or stupid	**0.74**	0.06	Self-punishment	Intrapersonal
17	Creating a physical injury that is easier to care for than my emotional distress	**0.44**	0.17	Self-care	Social
18	Trying to feel something (as opposed to nothing) even if it is physical pain	**0.87**	−0.15	Anti-dissociation	Intrapersonal
19	Responding to suicidal thoughts without actually attempting suicide	**0.66**	0.13	Anti-suicide	Intrapersonal
20	Entertaining myself or others by doing something extreme	−0.02	**0.51**	Sensation-seeking	Social
21	Fitting in with others	−0.23	**0.65**	Peer-bonding	Social
22	Seeking care or help from others	0.00	**0.67**	Interpersonal influence	Social
23	Demonstrating I am tough or strong	0.01	**0.64**	Toughness	Social
24	Proving to myself that my emotional pain is real	0.36	**0.47**	Marking distress	Intrapersonal
25	Getting revenge against others	−0.18	**0.81**	Revenge	Social
26	Demonstrating that I do not need to rely on others for help	0.10	**0.60**	Autonomy	Social
27	Reducing anxiety, frustration, anger, or other overwhelming emotions	**0.62**	−0.10	Affect regulation	Intrapersonal
28	Establishing a barrier between myself and others	0.15	**0.64**	Interpersonal boundaries	Social
29	Reacting to feeling unhappy with myself or disgusted with myself	**0.67**	0.08	Self-punishment	Intrapersonal
30	Allowing myself to focus on treating the injury, which can be gratifying or satisfying	0.22	**0.35**	Self-care	Social
31	Making sure I am still alive when I do not feel rea	**0.67**	−0.01	Anti-dissociation	Intrapersonal
32	Putting a stop to suicidal thoughts	**0.73**	0.12	Anti-suicide	Intrapersonal
33	Pushing my limits in a manner akin to skydiving or other extreme activities	0.26	**0.40**	Sensation-seeking	Social
34	Creating a sign of friendship or kinship with friends or loved ones	−0.24	**0.63**	Peer-bonding	Social
35	Keeping a loved one from leaving or abandoning me	−0.02	**0.58**	Interpersonal influence	Social
36	Proving I can take the physical pain	0.29	**0.59**	Toughness	Social
37	Signifying the emotional distress, I'm experiencing	0.15	**0.68**	Marking distress	Intrapersonal
38	Trying to hurt someone close to me	−0.23	**0.69**	Revenge	Social
39	Establishing that I am autonomous/independent	0.10	**0.77**	Autonomy	Social

Primary loadings are in bold.

predominantly treated in clinics for patients with non-psychotic mental disorders.

4.2. Internal consistency and factor structure

The Russian version of the ISAS-II has good overall internal consistency ($\omega = 0.85$), and the omega coefficients for the Intrapersonal (0.83) and Interpersonal (0.85) functions were either greater than 0.80 (Table 3). These data indicate a good internal consistency between these factors and are in line with the results of a study by Klonsky and Glenn (23) (Intrapersonal – 0.88 and Interpersonal – 0.89) and some

other studies (61). Interestingly, the internal consistency of the Intrapersonal factor functions was higher (range 0.71–0.83) than that of some of the Interpersonal factor functions (range 0.53–0.78). At the same time, although most of the NSSI motives had acceptable internal consistency ($\omega \geq 0.70$), the coefficients for "Self-care," "Sensation seeking," "Interpersonal boundaries" and "Peer bonding" ranged between 0.55 and 0.70, indicating less adequate reliability. The correlation between the Intrapersonal and Interpersonal functions in our sample was low (0.22). The average inter-item correlations for the Interpersonal and Intrapersonal functions and most of the subfunctions were within the acceptable range of 0.15–0.50.

An analysis of the distribution of items by factor (Intrapersonal and Interpersonal) in the Russian version of the ISAS-II revealed a

TABLE 3 Prevalence of NSSI functions and internal consistency and descriptive statistics for ISAS-II domains and facet scores.

	N (%)	Mean	SD	Skewness	Kurtosis	ω	Inter-item correlations
Intrapersonal functions		14.80	6.22	−0.11	−0.56	0.83	0.29
Affect regulation	590 (96.1%)	4.50	1.63	−1.12	0.61	0.71	0.44
Self-punishment	535 (87.1%)	3.65	2.09	−0.46	−1.11	0.83	0.62
Anti-suicide	466 (75.9%)	2.63	2.11	0.22	−1.26	0.83	0.61
Anti-dissociation	446 (72.6%)	2.55	2.15	0.27	−1.31	0.83	0.60
Interpersonal functions		7.90	6.57	1.22	2.10	0.85	0.18
Marking distress	484 (78.8%)	2.63	2.03	0.26	−1.13	0.75	0.49
Self-care	423 (68.9%)	1.47	1.35	0.89	0.68	0.55	0.26
Interpersonal influence	337 (54.9%)	1.35	1.59	1.00	−0.04	0.72	0.43
Toughness	330 (53.7%)	1.37	1.64	1.04	0.13	0.73	0.44
Sensation-seeking	260 (42.3%)	0.82	1.22	1.65	2.30	0.53	0.26
Interpersonal boundaries	185 (30.1%)	0.63	1.16	2.07	4.09	0.68	0.38
Autonomy	145 (23.6%)	0.52	1.16	2.70	7.48	0.75	0.49
Revenge	119 (19.4%)	0.39	1.00	3.36	12.40	0.78	0.53
Peer-bonding	73 (11.9%)	0.20	0.68	4.97	30.10	0.66	0.39

ISAS-II, the inventory of statements about self-injury; ω, McDonald's omega coefficient.

number of differences from the original version (Table 2). The main difference between the Russian version of the ISAS-II and the original version of the questionnaire was that all 3 items of the "Marking distress" subscale loaded more strongly on the Interpersonal factor. Previously, a study by Reinhardt et al. (62) found that "Marking distress" on a par with "Interpersonal boundaries," "Sensation Seeking," "Toughness" and "Autonomy" motives may have both Intrapersonal and Interpersonal components. In the same study, the "Marking distress" function had a salient loading on the Interpersonal factor in male adolescents. Our results are consistent with the study by Vigfusdottir et al. (63), conducted on a sample of Norwegian students, which also showed that the "Marking distress" function loaded more on the Interpersonal factor, in contrast to the original study by Klonsky and Olino (22). In the Korean study (28), − item 11 of the "Marking distress" function also loaded on interpersonal rather than intrapersonal functions.

Another feature of the Russian version of the ISAS-II was that the item 17 ("Creating a physical injury that is easier to care for than my emotional distress"), which in the original version belonged to the Interpersonal function "Self-care" (self-injuring to create a physical wound that one can care for more easily than one's emotional distress) (23), had a greater load on the Intrapersonal factor. The authors originally expected the "Self-care" function to be theoretically related to the intrapersonal factor, but in the original study this function had a higher load on the Interpersonal (0.41) than on the Intrapersonal factor (0.33) (23). It is interesting to note that in the original study the loading on the Interpersonal factor was only slightly higher than on the Intrapersonal factor. In a more recent study by Klonsky et al. (64), item analysis was performed and showed that item 17 loaded on the Intrapersonal (0.50) rather than the Social factor (0.26), which is fully consistent with our results. In the Russian version of the ISAS-II, the other two items of the "Self-care" function had high loadings on the Interpersonal factor, but the factor loadings were low. The "Self-care" function was also clearly loaded on the Intrapersonal function in the

studies by Kortge et al. (65), Vigfusdottir et al. (63), and Pérez et al. (25). In the last of the above-mentioned studies (25), the model in which the "Self-care" function was included in the Intrapersonal factor was found to be preferable to the original model in which it was identified as an Interpersonal function. It is also noteworthy that the other "Self-care" function items, although more heavily loaded on the Interpersonal factor, had some of the lowest loadings of all questionnaire items (0.4 for item 4 and 0.35 for item 30). Given the instability of the "self-care" subfunction (both the items within it and the subfunction as a whole) identified in several studies, we believe that developing a revised version of the ISAS based on the experience of the validations may be the best decision. A new version of the instrument should either clarify the wording of the questions or remove this function altogether.

Another ISAS-II item that showed low factor loadings on both factors was item 7 ("Doing something to generate excitement or exhilaration"), which refers to the "Sensation-seeking" function. Previously, the Korean study (28) found that, contrary to the original research, item 7 loaded more on the Intrapersonal than on the Interpersonal function.

4.3. NSSI functions in patients with suicidal ideation

In our study, patients practiced in NSSI for both Intrapersonal and Interpersonal motives (Table 3), which is consistent with most studies, but the prevalence differed from that presented in the meta-analysis by Taylor et al. (66). The three most common Intrapersonal NSSI functions in our sample were "Affect regulation" (96.1%), "Self-Punishment" (87.1%), and "Anti-Suicide" (75.9%), and the most common Interpersonal functions were "Marking distress" (78.8%), "Self-care" (68.9%), and "Interpersonal influence" (54.9%). In a meta-analysis by Taylor et al. (66), avoidance or escape from an unwanted internal state was also the

TABLE 4 Correlation analysis of NSSI functions with sociodemographic parameters, personality domains and clinical variables.

Parameter	Interpersonal functions	Intrapersonal functions
Age (#)	0.07	−0.39***
Male vs. female (@)	−0.04	0.27***
Schizophrenia spectrum disorder (@)	0.02	0.12
Bipolar disorder (@)	−0.05	0.05
Major depressive disorder (@)	−0.08	−0.08
Anxiety disorder (@)	0.00	−0.22***
Personality disorder (@)	0.12	013*
Multiple psychiatric diagnoses (@)	0.06	0.10
BDI score (#)	0.00	0.34***
STAI–S score (#)	0.07	0.26***
STAI-T score (#)	0.02	0.20***
PID5BF + M		
Negative affect (#)	0.13***	0.20***
Detachment (#)	0.04	0.16***
Antagonism (#)	0.25***	0.08
Disinhibition (#)	0.16***	0.21***
Anankastia (#)	0.18***	0.10**
Psychoticism (#)	0.20***	0.32***
SITBI		
(2) Age at SI onset (#)	−0.02	−0.18***
(84) Lifetime SA (@)	0.05	0.24***
(89) 12-month SA (@)	−0.08	0.22***
(85) SA age at onset (#)	0.12*	0.04
(88) N of SA (#)	0.05	0.08
(147) 12-month NSSI (@)	0.11	0.30***
(144) Age at NSSI onset (#)	−0.01	−0.18***
(150) N of NSSI methods (#)	0.13**	0.41***
(151) NSSI medical attention (@)	0.09	0.06
(153) Automatic negative reinforcement (&)	0.06	0.49***
(154) Automatic positive reinforcement (&)	0.14**	0.50***
(155) Social positive reinforcement (&)	0.42***	0.02
(156) Social negative reinforcement (&)	0.40***	0.18***
Precipitants		
(157) Family (&)	0.19***	0.16***
(158) Friends (&)	0.14**	0.19***
(159) Relationships (&)	0.19***	0.15***
(160) Peers (&)	0.05	0.09
(161) Work/school (&)	0.09	0.22***
(162) Mental state (&)	0.06	0.32***
(163) Drugs/alcohol use (% of time) (#)	0.17***	0.14**
(165) No. peers with NSSI before 1st time (#)	0.05	−0.07
(166) No. peers with NSSI after 1st time (#)	0.05	0.03
(167) Peer influence before 1st time? (&)	0.16**	−0.05
(167) Peer influence after 1st time? (&)	0.16**	0.03
Future likelihood of the NSSI (&)	0.00	0.35***

SI, suicidal ideation; SA, suicide attempt; NSSI, nonsuicidal self-injury; BDI, Beck's depression inventory; STAI-S, state–trait anxiety inventory-sate; STAI-T, state–trait anxiety inventory-trait; PID5BF + M, personality inventory for DSM-5 and ICD-11 brief form plus–modified; SITBI, self-injurious thoughts and behaviors interview. #, Pearson correlation; (#), biserial correlation; (&), polyserial correlation. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. @, biserial correlation.

most common Intrapersonal motive for NSSI, while communicating the level of distress and interpersonal influence were found to be the most common Intrapersonal motives. It is noteworthy that the "Self-care" motive for NSSI in the Russian version of the ISAS-II includes both Intrapersonal and Interpersonal items and cannot be completely reduced to just one of the two functions.

4.4. Correlations between NSSI functions and personality traits

We conducted a correlational analysis of Interpersonal and Intrapersonal functions with sociodemographic, clinical and personality profile variables. We also examined correlations between ISAS-II functions and parameters from the SITBI Non-suicidal self-injury module (items 144–169). We found small positive correlations (0.3–0.5) between Intrapersonal NSSI functions and lower age, higher BDI score, NSSI episode in the past 12 months, higher number of NSSI methods, "mental state at the time" as a cause of NSSI, and self-reported high likelihood of engaging in NSSI in the future. Our findings in the Russian-speaking patients on the relationship between Intrapersonal functions and the less favorable course of NSSI in patients with non-psychotic mental disorders are consistent with the results of studies conducted in other linguistic and cultural samples (67, 68).

To the best of the authors' knowledge, no correlational analysis has previously been conducted between DSM-5 personality trait domains and NSSI functions. At the same time, the relationship between NSSI behavior and higher levels of Negative affectivity, Detachment, Antagonism and Psychoticism has been previously reported by researchers (69–73). The Psychoticism domain of the PID-5 includes traits such as Unusual Beliefs & Experiences, Eccentricity, and Perceptual Dysregulation (74). According to Peng et al., patients with depression and NSSI have significantly higher levels of psychoticism than healthy controls and patients with depression alone (73). In addition, regression analysis showed that psychoticism was an independent risk factor for NSSI in depressed patients. These data are supported by the results of the study by Kang et al. (74). In our study, Intrapersonal NSSI functions had the highest correlations with psychoticism (0.32). In our opinion, this may be explained by the fact that psychoticism is associated with a well-known difficulty in dealing effectively with emotional conflict. For example, a study by Granieri et al. found that two immature defense mechanisms – autistic fantasy and isolation – predicted the PID-5 Psychoticism domain in participants (75). While attempts to cope with the unwanted effects of dissociation are among the most common Intrapersonal motives for NSSI, psychoticism has been repeatedly reported to be associated with a high risk for the development of dissociative phenomena (76).

In our study, NSSI Interpersonal functions had the highest correlations with the Antagonism domain (0.25). An association between NSSI and low agreeableness has also been reported in some previous studies (76–78). This variable indirectly reflects antagonism, which, according to the authors of the PID-5 (74), includes traits such as Manipulativeness, Deceitfulness and Grandiosity. The relationship found between Interpersonal functions and Antagonism is consistent with the suggestion by

some authors that some NSSI behaviors directed at the environment may involve aggressive goals (e.g., "Revenge" motives).

The SITBI questions related to self-harm motives (items 153–156) had the highest correlations with NSSI functions. The results were as expected: Interpersonal functions correlated with "… to communicate with someone else or to get attention?" (0.42) and "… to get out of doing something or to get away from others?" (0.40), and Intrapersonal functions with statements such as "… a way to get rid of bad feelings?" (0.49) and "… to feel something, because you were feeling numb or empty?" (0.50). These data provide general support for the convergent validity of the SITBI, but it is worth noting that none of the correlations exceeded the level of 0.5.

5. Conclusion

The results of our study indicate that the Russian version of the ISAS-II is a valid and reliable instrument for assessing NSSI functions in a population at high risk for suicide attempts. Factor analysis of the Russian version of the ISAS-II revealed a two-factor structure (Intrapersonal and Interpersonal factors) of the instrument. The main difference between the Russian version of the instrument and the original study is that all 3 items of the subfunction "Marking distress" load more heavily on the interpersonal factor. The three most common Intrapersonal NSSI functions in patients with suicidal ideation were "Affect regulation," "Self-punishment," and "Anti-Suicide," and the Interpersonal functions were "Marking distress," "Self-care," and "Interpersonal Influence." In people with non-psychotic mental disorders and suicidal thoughts, Interpersonal functions are associated with more severe depressive symptoms, less favorable course of NSSI and psychoticism personality traits. Validation of the ISAS-II in Russian will help to develop more accurate therapeutic strategies for people with specific motives for NSSI and will be useful for Russian mental health professionals in assessing the further course of NSSI.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors upon request.

Ethics statement

All procedures in studies involving human participants were conducted in accordance with the ethical standards of the Research Ethics Committee of the Moscow Research and Clinical Center for Neuropsychiatry. Informed consent was obtained from all participants included in the study. 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

MZ: Conceptualization, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing. GK: Data

curation, Writing – original draft. SP: Investigation, Writing – original draft. IM: Writing – original draft. NV: Writing – original draft, Investigation. AnG: Formal analysis, Methodology, Writing – original draft. AY: Formal analysis, Software, Writing – original draft. AlG: Project administration, Resources, Writing – review & 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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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpubh.2023.1270944/full#supplementary-material

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Peer effects and health impacts of different body cognitive biases in children: micro evidence from China

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Background: In China, children commonly display body cognitive biases, which constitute a significant yet hidden public health issue. These biases potentially jeopardize children's well-being, hinder the cultivation of human capital, and impede societal progress. However, limited research employs theoretical analysis and econometric testing to investigate the formation of different body cognitive biases among Chinese children and their health impacts.

Methods: Based on a local average network model for theoretical analysis, this study utilizes a sample of 4,289 children from four phases of the China Health and Nutrition Survey (CHNS) conducted from 2004 to 2011. Utilizing Logit and IV Probit models, systematically evaluate the peer effect, heterogeneity of effects, and health impacts of children's different body cognitive biases.

Results: (1) The peer effect contributes to the development of light- and heavy-body cognitive biases in Chinese children. (2) The heterogeneity analysis shows that the peer effect of body cognitive biases is more significant in rural and female children. (3) The influence of heavy-body cognitive bias is more pronounced in adolescent children. (4) The "eating-activity balance" is disrupted by the two body cognitive biases in children, leading to deviations from normal body type. (5) Specifically, the light-body cognitive bias leads children to intake more and burn fewer calories, increasing their risk of obesity. (6) Conversely, the heavy-body cognitive bias prompts children to intake less and expend more calories, resulting in a higher prevalence of thinness.

Discussion: This study innovates by exploring peer effects on body cognitive biases in Chinese children, elucidating their direction and health implications. While overweight and obesity are recognized as overt health issues, the spread and impact of implicit issues like body cognitive biases should not be overlooked. Nevertheless, the issue is largely neglected in developing countries, such as China, where existing children's health policies are inadequate in addressing it. Promoting accurate body image perception and understanding of health prevention strategies among children requires adequate attention to peer effects.

KEYWORDS

Children's body cognitive biases, peer effects, health impacts, diet, sports, body type

1 Introduction

Throughout their growth, children face a range of physical health challenges. Traditionally, academics have concentrated on objective physical issues such as overweight, obesity, and malnutrition, yet have not given sufficient attention to body cognitive biases. However, researches indicates that body cognitive biases constitute a significant yet underreported public health issue in China, particularly among young children (1–3). Discrepancies between self-perceived and actual body types represent cognitive biases (4, 5). It and body image dissatisfaction contribute to eating disorders (6), inadequate body management (7), self-worth depreciation (8), social withdrawal (9), reduced self-esteem and autistic depression (10). As children physically and mentally develop, their self-consciousness about their appearance increases (11). Variations in body shape cognition can disrupt growth patterns, posing physical and mental health risks, that threaten the long-term well-being of individuals, families, and nations.

However, the spread and risks of body cognitive biases in Chinese children remain unaddressed in policy-making due to insufficient research. The government primarily promotes resolving obesity and malnutrition in children through various approaches, including reasonable diet, nutritional supplements, and physical exercise.[1] Instead of studying the emergence of children body cognitive biases, more research is focused on the development of body image dissatisfaction. The causes of body image dissatisfaction can be grouped into four categories: individual social comparisons (12); mass media-driven perception dissemination and socio-cultural transmission (13); peer review (14); parental misperceptions and teaching (15). However, body image dissatisfaction and body cognitive biases are not identical. Body image dissatisfaction can sometimes reflect accurate body condition cognition, whereas body cognitive biases are purely illusory. Furthermore, body image includes various aspects like body form and appearance, which are not equivalent to body type (16). Hence, the formation of body cognitive biases in children necessitates additional research.

Children's logical reasoning, value judgments, and social cognitive abilities are immature and susceptible to external pressures, such as group reference and peer standards, which may distort their development (17). Based on this point, peer social networks significantly impact children's health. In terms of physical health, research demonstrated the peer effect on obesity (18), smoking (19), alcohol consumption (20), marijuana use (21), poor fitness (22) and so on. In the field of mental health, investigations into peer effects primarily concentrate on the spread of depression, anxiety, and stress [e.g., (23)]. Nonetheless, most existing research on peer effects rarely explores individual cognition, with only a few studies examining the development of body cognitive biases. It is worth noting that certain literature offers promising research clues regarding the presence of peer effects in children's body cognitive biases. Some indicates that peer assistance can help improve cognitive and dietary disorders (24). Additionally, normative changes may be an effective mechanism for group psychotherapy

(25). More direct clues pointing out misconceptions about peer weight norms or accepting incorrect weight comments from peers may directly influence one's weight development (26). Peer groups' cognitive norms about body type may affect individual child's perception, yet few studies have comprehensively examined this from the peer effects perspective using empirical econometric models for validation.

To effectively address children's body cognitive biases and adverse consequences, existing research has four main limitations: Firstly, lack of theoretical models and in-depth analysis. The analysis of peer in past studies mainly depends on empirical evidence or simple arguments. However, in other fields of peer effects research, there are existing theoretical models that can be referred to, such as the local average network model (27). Secondly, lack of empirical analysis. The majority of related research employed correlational analysis without rigorous econometrics (1–3, 6–10). Thirdly, lack of attention to children. Previous studies have mainly focused on women and youth groups (4, 28, 29). Given the early onset, widespread prevalence, and enduring consequences of body cognitive bias, children's groups merit further investigation. Fourthly, lack of research evidence from China. With neither domestic nor international studies providing adequate explanations for the spread of body cognitive biases and health hazards among Chinese children.

Based on the preceding analysis, this study aims to investigate the following questions: Do children's body cognitive biases exhibit peer effects? If affirmative, are there discrepancies among different characteristic groups such as age, gender, and urban–rural dimensions? Do different types of body cognitive biases have diverse impacts on children's health? What are the mechanisms behind these varying impacts? Addressing these issues is crucial for boosting Chinese children's health awareness, reducing early health risks.

This study employs CHNS data to explore the peer effects of children's body cognitive biases, discerning light- and heavy-body cognitive biases according to subjective and objective body measures. It subsequently addresses endogeneity issues and analyzes the transmission of these biases across various dimensions, along with heterogeneity impacts on healthy body types and core mechanisms. It is structured as follows: Section 2 develops a theoretical framework; Section 3 presents estimation strategies; Section 4 conducts descriptive analysis; Section 5 analyzes empirical results; and Section 6 concludes with discussions.

The contributions include: (1) being the first to investigate the propagation of body cognitive biases among Chinese children; (2) uncovering peer effects and elucidating health consequences across various bias directions; (3) extending the application of peer effects to mental health and cognition.

2 Theories and hypotheses

2.1 Analysis clues: derived from a simplified local average network model

The local average network model, introduced by Patacchini and Zenou, was developed to study the impact of adolescent conformity on individual criminal (27). This model was later adapted to examine the influence of peer alcohol consumption on individual drinking habits (20). Refer to both studies, we construct a simplified local

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average network model, offering analytical insights for subsequent theoretical discussions.

Assuming a community has n children, $N = \{1, \ldots, n\}$ represents a finite set of agents. The n-square adjacency matrix H represents pairwise relationships among all children in community h. In this context, children i and j connect directly (i.e., best friends), then $h_{ij} = 1$; otherwise, $h_{ij} = 0$. Considering friendship as a mutual relationship, set $h_{ij} = h_{ji}$, $h_{ii} = 0$.

$y_i(h)$ denotes the effort level of child i in community h. It refers to the child's own body cognition tendency towards a certain body cognitive bias in this community. We define $\overline{y}_i(h)$ as the average effort of other children in community, reflecting the average level of a specific body cognitive bias in Eq. 1:

$$\overline{y}_i(h) = \frac{1}{h_i} \sum_{j=1}^{j=n} h_{ij} y_j. \tag{1}$$

We will implicitly omit parameter h in subsequent analysis unless further explanation is needed. Child i chooses an effort level $y_i \geq 0$, yielding utility $u(y_i, \overline{y}_i)$ with a standard cost/benefit structure. In Eq. 2, a, $c > 0$ and $b_i > 0$ for all i.

$$u_i(y_i, \overline{y}_i) = a + b_i y_i - p y_i f - c(y_i - \overline{y}_i)^2 \tag{2}$$

The benefits of children's body cognitive bias, represented by $a + b_i y_i$, increases with his/her effort y_i. b_i denotes individual heterogeneity, reflecting the utility benefit multiplier from child i's body cognitive bias. Within the community, all children have observable utility benefit multipliers associated with various individual and environmental factors, such as gender, age, and community tightness, where x_i^m represents child i's characteristic variables, explaining differences between i and others. β_m is the parameter:

$$b_i(x) = \sum_{m=1}^{M} \beta_m x_i^m \tag{3}$$

In Eq. 2, the cost of body cognitive bias $p y_i f$ comprises two parts: $p y_i$, the expected loss probability, positively correlated with y_i. f embodies the health cost of body cognitive bias, reflected in erroneous body management behaviors and their health consequences. $c(y_i - \overline{y}_i)^2$ signifies the psychological utility loss from individual behavior deviation. Assuming children strive for minimal social distance with the reference group, parameter c portrays their compliance preference.

The payoff function in a pure strategy compliance game, represented by Eq. 2, has a unique Nash equilibrium, given by Eq. 4:

$$y_i^* = \overline{y}_i + (b_i - pf) / 2c \tag{4}$$

Equation 4 shows child i's equilibrium effort y_i^* is positively linked to the reference group's average effort $\overline{y}_i$, as Eq. 5:

$$\partial y_i^* / \partial \overline{y}_i > 0 \tag{5}$$

Furthermore, y_i^* increases with utility benefit multiplier b_i and decreases with health cost pf for a given $\overline{y}_i$:

$$\partial y_i^* / \partial b_i > 0 \tag{6}$$

$$\partial y_i^* / \partial pf < 0 \tag{7}$$

2.2 Logical expansion: behavioral mechanisms of peer effects in children's body cognitive biases

Based on the theoretical framework and partial derivatives mentioned above, we further expand the relevant logic.

Equation 5 shows that peer influence impacts children's body cognitive biases. The Social Cognitive Theory (SCT) suggests that the beliefs of surrounding others are crucial components of an individual's social environment [30]. Discrepancies with group beliefs may cause shame, guilt [31] and lead to negative evaluations and social isolation [32]. Children frequently use peer group norms as reference points, altering their behavior to show a desire to imitate and conform. Furthermore, the Social Learning Theory (SLT) suggests that observation and imitation are crucial for behavior acquisition in the face of asymmetric information [33]. Children, in a critical stage of mental development, exhibit strong plasticity and face challenges in independent decision-making. They adapt their behaviors by observing and imitating peers in their community, integrating and inferring information. So children in a community internalize physical cognition concepts as group norms (i.e., average body cognitive biases among remaining children in the same community $\overline{y}_i$). Thereby applying pressure and information on children's perceptions and behaviors [34]. It creates group pressure, spreads group concept info, and fosters individual children's body cognitive biases y_i^*.

By analyzing Eqs 4, 7, children's understanding of health risks (pf) related to body cognitive biases may mitigate peer effects. However, as a subjective hidden health issue, children and caregivers often lack adequate health knowledge and risk awareness. For example, caregivers also hold misconceptions about children's body shapes [35].

> *Hypothesis 1*: There are peer effects in children's body cognitive biases. A stronger group inclination towards a heavy-/light-body cognitive bias prompts children to develop a similar bias.

Equation 6 suggests that increased utility and satisfaction from adopting group perspectives and norms (i.e., b_i (x_i^m) grow) converge children's body cognition with the group. Equation 3 suggests different x_i^m offer children heterogeneous utility benefit multipliers $b_i(m)$. It allows for a thorough exploration of peer effects of body cognitive biases in various dimensions.

Firstly, the dimension of community characteristics. Children from various communities interact with diverse social networks, leading to peer effects. Social networks' structural features include number, mobility, and connectedness (36). An increase in the number of network members enhances density, facilitating more information and behavioral exchanges within groups. Stronger interpersonal linkages amplify the influence of group values and norms on individual behavior. In contrast, urban communities have fewer extensive blood and kinship ties, daily interactions, and communication compared to rural communities. According to Eq. 3, rural communities in China demonstrate stable membership, cohesive living conditions, and heightened child-to-child interactions. Social norms and attitudes have a more significant impact on rural children (i.e., $b_{i,\text{rural}} > b_{i,\text{urban}}$).

> *Hypothesis 2*: Rural children are more susceptible to the influence of peer effects on body cognitive biases compared to their urban counterparts.

Secondly, the dimension of gender characteristics. Gender awareness among children is escalating (37). Local culture can influence ideal body shape stereotypes (38). Traditional Chinese culture and aesthetics shape societal expectations and gender norms concerning body types, prioritizing masculinity and strength for men, and slimness and softness for women (39). According to the Gender Schema Theory (40), individuals' assumed roles or identities correspond to particular social expectations, and any deviation may lead to public pressure or losses. Children's peer environments demonstrate differences in biological and social genders. So male children benefit more from adhering to the group's light-weight body cognitive bias norms, the situation is reversed for female children (i.e., $b_{i,\text{boy,light-body cognitive bias}} > b_{i,\text{boy,heavy-body cognitive bias}}$, $b_{i,\text{girl,heavy-body cognitive bias}} > b_{i,\text{girl,light-body cognitive bias}}$). Furthermore, women are more vulnerable to experiencing beauty premiums and ugly penalties in learning, employment, and marriage (41, 42), and they are at a higher risk of experiencing body shape anxiety. Considering these issues, females are more likely to engage in conversations about beauty and body type (29). Group body cognitions have a more substantial impact (i.e., $b_{i,\text{girl}} > b_{i,\text{boy}}$).

> *Hypothesis 3*: Light-body cognitive biases have a stronger peer influence on male children, while heavy-body cognitive biases are more influential on female children. In general, females are more prone to peer influence.

Finally, the dimension of age characteristics. Adolescents tend to rebel, question adult authority, and challenge the views and guidance of parents and teachers (43). Adolescent children exhibit increased intimacy with their peers, are more likely to derive a sense of belonging and identity from peer groups (33), and are more susceptible to the influence of group physical concepts. Adolescent children's self-assessments of their internal and external appearance fluctuate (34), and they are concerned with mainstream social aesthetics. In today's society, which values facial attractiveness and body shape, adolescents are more prone to heavy-body cognitive biases. Given these concerns, $b_{i,\text{adolescence}} > b_{i,\text{non-adolescence}}, b_{i,\text{adolescence,heavy-body cognitive bias}} > b_{i,\text{adolescence,light-body cognitive bias}}$.

> *Hypothesis 4*: Adolescent children are more affected by peer effects regarding body cognitive biases than non-adolescents, particularly the heavy-body cognitive bias.

3 Methodology and variables

3.1 Sample

The China Health and Nutrition Survey (CHNS) is an international collaborative effort conducted by the University of North Carolina at Chapel Hill and the Chinese Center for Disease Control and Prevention.[2] This survey has been carried out in 1989, 1993, 1997, 2000, 2004, 2006, 2009, 2011, and 2015. The multistage random cluster sampling method employed in the survey, which is based on distinct income levels (high, medium, and low) and weighted sampling, involves the following steps: after randomly selecting four counties and two cities within each province, the CHNS randomly identifies villages and towns in each county, as well as urban and suburban regions in each city. Subsequently, 20 households are selected from each of these communities. The survey covers provinces such as Liaoning, Heilongjiang, Jiangsu, Shandong, Henan, Hubei, Hunan, Guizhou, and Guangxi. These locations can be found at: https://www.cpc.unc.edu/projects/china/about/proj_desc/chinamap. In 2011, Beijing, Shanghai, and Chongqing were incorporated into the study. The control variables in this paper encompass parents' knowledge of dietary guidelines. As the indicators for this variable were only available from 2004 onwards, and we lacked comprehensive access to the CHNS 2015 data, we examined four periods of mixed cross-sectional data spanning 2004 to 2011, covering children aged 6 to 17 years. Samples with missing crucial data, logistic anomalies, or severe physical limitations (e.g., blindness, arm function loss, leg function loss) were excluded, resulting in 4,289 valid observations. Due to variable availability, the sample size was reduced when estimating and detecting the health effects of body cognitive biases using instrumental factors.

Although not the latest, CHNS2004-2011 remains a valuable resource for studying peer effects on children's body cognitive biases. The CHNS is the only public dataset currently recording subjective and objective body data for Chinese children. The detailed personal, familial, and community characteristics in the CHNS dataset aid in conducting quantitative empirical tests on peer effects. As discussed, the Chinese government's lack of policy addressing children's body cognitive biases justifies the concern over its presence in modern China.

3.2 Empirical strategy

3.2.1 Validate peer effects

To investigate peer effects on children's body cognitive biases, a logit model was constructed with group body cognitive biases as the core independent variables, and children's body cognitive bias as the dependent

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variable, using a heteroscedasticity-robust standard error. Referring to Lee (44), the econometric model is specified as Eq. 8 and Eq. 9.

$$y_{ict} = \alpha_0 + \alpha_1 \overline{y_{-ict}} + \alpha_2 X_{ict} + \alpha_3 Z_{ict} + \varepsilon_{ict} \quad (8)$$

$$\overline{y_{-ict}} = \left(\sum y_{ict} - y_{ict}\right)/\left(N_{ct} - 1\right) \quad (9)$$

where y_{ict} denotes that child i in community c exhibits a light- or heavy-body cognitive bias during period t; $\overline{y_{-ict}}$ represents the mean of children's body cognition biases (light- or heavy-body cognitive biases) in period t, except for child i, in the community c; X_{ict} represents the child and familial characteristic factors; Z_{ict} represents the characteristics of child's community; ε_{ict} serves as the model perturbation term. N_{ct} denotes the total number of children residing in community c during period t.

3.2.2 Relieve endogeneity

As Manski (45) stated, the study of peer effects often encounters the common issue of reflexivity. Synchronous cognition transmission may result in reverse causality in assessing peer effects. To address it, we employ instrumental variables and the IV-Probit econometric model as Eq. 10–12.[3]

$$y_{1,ict}^* = \alpha x_{ict} + \phi y_{2,ict} + \mu_{ict} \quad (10)$$

$$y_{2,ict} = \gamma x_{ict} + \eta X_{ict} + v_{ict} \quad (11)$$

$$y_{1,ict} = 1\left(y_{1,ict}^* > 0\right) \quad (12)$$

The observable dummy variable $y_{1,ict}$ indicates whether the child has a light- or heavy-body cognitive bias; $y_{1,ict}^*$ represents the corresponding latent variable. Meanwhile, $y_{2,ict}$ serves as the endogenous independent variable; μ_{ict}, v_{ict} denote the perturbation terms.

3.2.3 Validate health impacts

To examine health impacts, a logit model was constructed with "*Body Type Deviation*" as the dependent variable (including deviations from normal body type, tendencies toward overweight, and tendencies toward thinness). The child's body cognitive bias serves as the core independent variable. Given the common factors influencing health related issues, the control variables align with the baseline model as Eq. 13.

$$\delta_{ict} = \beta_0 + \beta_1 y_{ict} + \beta_2 X_{ict} + \beta_3 Z_{ict} + \tau_{ict} \quad (13)$$

When δ_{ict} represents whether the body type deviates from the norm, the two types of children's body cognitive biases y_{ict} act as core

independent variables. When δ_{ict} suggests a tendency towards overweight, the light-body cognitive bias act it; and when it suggests a tendency towards thinness, the heavy-body perception bias act it.

3.3 Variables

3.3.1 Dependent variable: y_{ict}

y_{ict} represents the light- or heavy-body cognitive bias of child i in community c during period t. Value 1 indicates the presence of the body cognitive bias, while 0 signifies its absence. The CHNS dataset comprises objective body indicators such as weight and height. And the survey inquires "Do you think you are now underweight, normal or overweight?" to ascertain the child's body cognitive type.[4]

The 2016 Dietary Guidelines for Chinese Residents[5] include a children's BMI metric in its appendix.[6] BMI intervals were defined based on the age and gender of children to define overweight, normal, and underweight. We utilized children's BMI and the classification criteria from the guidelines to objectively determine body types.

Referring to existing literature (4, 5), the following situations belong to light-body cognitive bias: children who have a normal body type but believe they are underweight; children who are overweight but believe they are underweight or normal. The following situations belong to heavy-body cognitive bias: children who have a normal body type but believe themselves as overweight; thin body type but believe themselves as normal, or overweight.

3.3.2 Core independent variable: $\overline{y_{-ict}}$

The core independent variable $\overline{y_{-ict}}$ represents the mean level of light- or heavy-body cognitive biases among all children in community c and period t, excluding child i. It's a [0, 1] continuous variable. Value 0 indicates that no children in the group exhibit body cognitive biases, while value 1 signifies that all children do.

3.3.3 Control variables

Manski (45) highlighted the challenges in accurately identifying peer effects, citing interference from correlated effects and exogenous effects. The correlated effect, in this context, pertains to the co-relation in body cognitive biases among individuals within a community, potentially induced by unobservable yet similar critical factors among these individuals. The exogenous effect denotes the influence of shared environmental factors on the body cognitive biases of diverse individuals.

To overcome interference factors and precisely identify peer effects, we select the following control variables: firstly, in terms of correlated effects, owing to the random assignment of individuals within the same community in the CHNS data, rather than being a consequence of children's self-selection, this approach effectively mitigates the correlation effects arising from self-selection biases (18). Secondly, in terms of exogenous effects, reviewing Huang et al. (46), we refined the relevant control variables in order to isolate exogenous

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3 Details for model explanation: https://www.stata.com/manuals/rivprobit.pdf

4 https://www.cpc.unc.edu/projects/china/data/questionnaires/

5 http://dg.cnsoc.org/article/2016b.html

6 It aligns with Chinese screening norms for malnutrition and for overweight/ obesity in children: http://www.nhc.gov.cn/wjw/pqt/201407/ffa.shtml, http://www.nhc.gov.cn/wjw/pqt/201803/a7962d1ac01647b9837110bfd2 d69b26.shtml

effects from endogenous effects. Considering children's height and body size, as well as social aesthetics, vary by province and evolve over time, fixed effects for province and survey year were introduced to control for unobserved group effects (47). To manage the impact of the community environment and gathering places for children, we incorporated three variables: the community food environment (have fast food restaurants or not), leisure activity environment (have recreational activity venues or not), and internet entertainment environment (have Internet cafes or not). Additionally, we regulated for the children's individual characteristics (gender, age, education level, etc.) and family attributes (number of siblings, average parental age, average parental BMI, highest parental education level, parental living conditions, annual family income, and parental awareness of dietary guidelines, etc.), as well as family residency.[7]

4 Descriptive statistics

The descriptive statistics for the variables are presented in Table 1. The sample showed that over half of the Chinese children surveyed face body cognitive bias issues, 38% of participants had a heavy-body cognitive bias, while 13% had a light-body cognitive bias. Given the sample's wide geographical distribution and lack of policy attention to this issue, it is possible that the current situation with body cognitive bias among Chinese children is more severe. The sample had a nearly 1:1 gender ratio and a reasonable distribution. The age range of 6–17 years old represents the majority of children still in education, reflecting the reality of the situation.

A comparison was drawn between normal-shaped children and those who were thin, overweight, and obese to examine the distribution of body cognition. Table 2 reveals that over 20% of normal-shaped children perceived their body shapes as abnormal, while more than 60% of children with abnormal body shapes believed their shapes were normal. These findings suggest that body cognitive biases are common among Chinese children, especially those with atypical body types.

Table 3 reveals that children with light-body cognitive biases exhibit a higher group light-body cognitive bias level (0.17) compared to those without such biases (0.11), as indicated in column 4. Similarly, column 3 shows that children with heavy-body biases have a higher group heavy-body cognitive bias level (0.41) than those without heavy-body cognitive biases (0.34). Column 5 reveals that 33% of children with light-body biases and 11% of those with heavy-body biases have normal body shapes. The proportion of normal body types in both groups is lower than in children without cognitive biases.

5 Results

5.1 Baseline results

Table 4 presents the Logit marginal regression results of peer effects for both body cognitive biases. Columns 1 and 3 only include core

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independent variables and the dependent variable. Columns 2 and 4 further control for individual, family, and community characteristics. Column 2 shows a 14.2% increase in child's light-body cognitive bias likelihood for each 1-unit increase in the community's group light-body cognitive biases ($p < 0.01$). Similarly, Column 4 indicates a 13.8% surge in heavy-body cognitive bias probability for every 1-unit increase in the community's group heavy-body cognitive biases ($p < 0.01$). Hypothesis 1 is not rejected. The control variables estimations were consistent with the known empirical experiences.

5.2 Robustness tests

The robustness of the baseline regression is assessed by utilizing joint fixed effects, excluding specific samples, considering survey months, and applying "dummy peer" counterfactuals. Table 5 presents the test results, supporting the conclusion of baseline regression.

1. Using joint fixed effects. Although province and year fixed effects were considered in the baseline regression, district-level factors varying by year might have been overlooked. To account for regional trend effects, we incorporated joint year-provincial fixed effects. Columns 1 and 2 indicate that the child's light-body cognitive bias likelihood increases by 10.8% ($p < 0.01$) and heavy-body cognitive bias probability surges by 11% ($p < 0.01$) for each 1-unit increase in the community's corresponding group cognitive biases.

2. Excluding non-school sample. School-aged children (6–17 years) are typically found in a school setting. However, some are no longer in school due to personal, familial, and institutional factors, leading to increased community time and peer pressure. On the other hand, these may experience heightened social isolation and detachment from peers. To minimize potential impacts, non-enrolled children are excluded. Columns 3 and 4 demonstrate that light-body cognitive bias likelihood increases by 14.5% ($p < 0.01$) and heavy-body cognitive bias probability surges by 12.8% ($p < 0.01$) with each 1-unit increase in the community's corresponding group cognitive biases.

3. Excluding recent sickness sample. Children experiencing health shocks with increased risk perception may reevaluate their body type and adjust body cognition (48). To mitigate the impact of recent health risk shocks, unwell or injured children within four weeks prior to the interview were excluded. Columns 5 and 6 support the baseline findings, light-body cognitive bias likelihood increases by 14.3% ($p < 0.01$) and heavy-body cognitive bias probability surges by 13.8% ($p < 0.01$) per 1-unit increase in the community's corresponding group cognitive biases.

4. Controlling survey month. Cold environments result in heavier, warmer clothing, decreasing peer visibility and peer effects, whereas warm weather prompts lighter attire. Consequently, the baseline regression incorporates survey month. Columns 7 and 8 demonstrate that light-body cognitive bias likelihood increases by 13.3% ($p < 0.01$) and heavy-body cognitive bias probability rises by 13.5% ($p < 0.01$) with each 1-unit increase in the community's corresponding group cognitive biases.

TABLE 1 Descriptive analysis of main variables (*N* = 4,289).

Variables	Variable assignment	Mean	SD	Min	Max
Dependent variables					
Heavy-body cognitive bias	1 = yes, 0 = no	0.38	0.49	0	1
Light-body cognitive bias	1 = yes, 0 = no	0.13	0.33	0	1
Core independent variables					
Group heavy-body cognitive bias	0–1	0.37	0.23	0	1
Group light-body cognitive bias	0–1	0.12	0.16	0	1
Control variables					
Child's gender	1 = male, 0 = female	0.53	0.50	0	1
Child's age	years old	11.55	3.25	6	17
Child's education level	codes, 0–5	1.06	0.98	0	5
Child's school attending	1 = yes, 0 = no	0.94	0.25	0	1
Child's siblings	individual	0.32	0.57	0	3
Parents' highest education level	codes, 0–6	2.46	1.21	0	6
Parents' average age	years old	38.67	4.98	26	54.5
Parents' average BMI	kg/m^2	23.12	2.52	15.82	33.85
Father's home situation	1 = home, 0 = outside	0.14	0.35	0	1
Mother's home situation	1 = home, 0 = outside	0.02	0.15	0	1
Parents' knowledge of dietary guidelines	1 = know, 0 = not know	0.20	0.40	0	1
Annual household income	million yuan/year	2.71	2.88	0	14.6
Community's leisure activities place	1 = yes, 0 = no	0.21	0.41	0	1
Community's fast food restaurants	1 = yes, 0 = no	0.22	0.42	0	1
Community's Internet Cafe	1 = yes, 0 = no	0.44	0.50	0	1
Family residences	1 = urban, 0 = rural	0.31	0.46	0	1
Child's average daily caloric intake[a]	kcal/day	1741.53	591.41	657.79	3526.29
Child's sports activities participation[b]	1 = yes, 0 = no	0.85	0.36	0	1

Codes: 0 illiterate, 1 elementary school, 2 junior high school, 3 high school, 4 polytechnic school, 5 university 6 master and above.[a]Due to the absence of this indicator in some samples, the actual number of regression samples in identifying the health effect mechanism of form cognitive bias was 4166.
[b]Similarly, the actual sample size of the latter regression is 3,940 due to the absence of this indicator in some samples.

TABLE 2 Distribution of body cognition among children with different body types.

Body cognition	Normal body type		Abnormal body type	
	Number of samples	Proportion %	Number of samples	Proportion %
Light-	180	11.52	730	26.77
Normal-	1,203	77.02	1,697	62.23
Heavy-	179	11.46	300	11.00
Total	1,562	100	2,727	100

Compiled from CHNS data (2004–2011).

TABLE 3 Comparison of group bias, gender distribution, and body size deviation for body cognitive biases.

Child's body cognitive biases	Presence	Group heavy-body cognitive bias level	Group light-body cognitive bias level	Proportion of normal body type
Light-	No	0.38	0.11	0.37
	Yes	0.31	0.17	0.33
Heavy-	No	0.34	0.13	0.52
	Yes	0.41	0.10	0.11

Compiled from CHNS data (2004–2011).

TABLE 4 Peer effects for the two types of body cognitive biases.

Variables	Light-body cognitive bias		Heavy-body cognitive bias	
	(1)	(2)	(3)	(4)
Group light-body cognitive bias	0.233***	0.142***		
	(8.443)	(4.842)		
Group heavy-body cognitive bias			0.293***	0.138***
			(9.478)	(4.347)
Child's gender		0.049***		−0.005
		(4.804)		(−0.388)
Child's age		−0.008**		−0.028***
		(−2.316)		(−5.404)
Child's education level		0.013		−0.034**
		(1.165)		(−1.991)
Child's school attending		−0.047**		0.132***
		(−2.328)		(3.763)
Child's siblings		−0.012		0.011
		(−1.085)		(0.861)
Parents' highest education level		−0.001		−0.002
		(−0.137)		(−0.218)
Parents' average age		−0.000		−0.002
		(−0.247)		(−0.940)
Parents' average BMI		0.004*		−0.013***
		(1.898)		(−4.390)
Father's home situation		0.011		0.011
		(0.734)		(0.535)
Mother's home situation		−0.025		−0.000
		(−0.693)		(−0.005)
Parents' knowledge of dietary guidelines		−0.013		−0.017
		(−0.948)		(−0.857)
Annual household income		0.003		−0.007**
		(1.612)		(−2.510)
Community's leisure activities place		0.012		−0.015
		(0.928)		(−0.779)
Community's fast food restaurants		0.024*		−0.010
		(1.772)		(−0.526)
Community's internet cafe		0.003		0.002
		(0.267)		(0.114)
Family residences		0.019*		−0.045***
		(1.680)		(−2.688)
Year fixed effects	No	Yes	No	Yes
Provincial fixed effects	No	Yes	No	Yes
N	4,289	4,289	4,289	4,289

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$; z-values under robust standard errors are in parentheses.

5. Counterfactual test. To eliminate county-level correlation effects, we adopted Li's study (49), where children from other communities in the same county were randomly sampled with put-back and matched to target community children as "dummy peers." Light- and heavy-body cognitive biases were then recaptured. The non-significant "dummy peer" effect in columns 9 and 10 indicated no county-level correlation impact.

TABLE 5 Robustness test results.

Panel A					
Variables	(1) Light-	(2) Heavy-	(3) Light-	(4) Heavy-	(5) Light-
Group light-body cognitive bias	0.108***		0.145***		0.143***
	(3.722)		(4.885)		(4.708)
Group heavy-body cognitive bias		0.110***		0.128***	
		(3.435)		(3.855)	
Control variables	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes
Year-province fixed effects	Yes	Yes	No	No	No
N	4,289	4,289	4,011	4,011	3,901
Panel B					
Variables	(6) Heavy-	(7) Light-	(8) Heavy-	(9) Light-	(10) Heavy-
Group light-body cognitive bias		0.133***			
		(4.504)			
Group heavy-body cognitive bias	0.138***		0.135***		
	(4.166)		(4.252)		
Group light-body cognitive bias I				0.009	
				(0.259)	
Group heavy-body cognitive bias I					−0.003
					(−0.097)
Control variables	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes	Yes
Year-province fixed effects	No	No	No	No	No
August		0.040	−0.035		
		(0.872)	(−0.592)		
September		0.052	−0.029		
		(1.158)	(−0.497)		
October		0.070	−0.044		
		(1.548)	(−0.738)		
November		0.083*	−0.048		
		(1.819)	(−0.801)		
December		0.115**	−0.058		
		(2.240)	(−0.863)		
N	3,901	4,289	4,289	4,289	4,289

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$; z-values under robust standard errors are in parentheses.

6. Semiparametric method. We estimated a semiparametric partially linear model (PLM), using Robinson's double residual method (50). Figures 1, 2 reveal a positive relation between group body cognitive bias levels and individual body cognitive bias.

5.3 Endogenous issues

When assessing peer effects, synchronous perception transmission can create reverse causal endogeneity, biasing coefficient estimates. Referring to Sund (51), we use the lagged level of group body cognitive bias as an instrumental variable and using IV Probit model to estimate peer effects. Given that CHNS survey intervals are 2–3 years and community composition remains stable in the short term, cognitive biases in the lag period are closely related to the current period, unaffected by the current period's perturbation term, thus representing a suitable instrumental variable. However, the CHNS data contains samples with tracking failures, reducing the sample size. Table 6 column 1 and 3 reveals the first-stage F-test values for heavy- and light-body cognitive biases are 27.768 and 24.561, respectively, suggesting no weak instrumental variable issue.
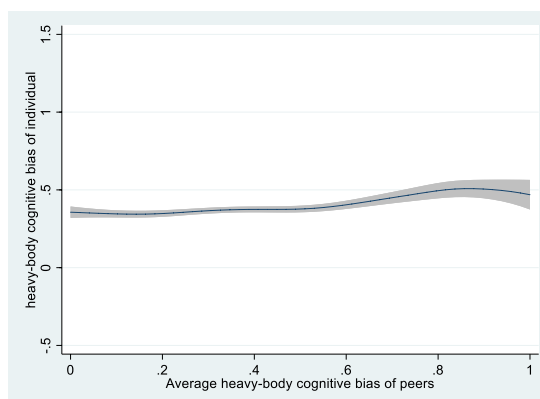
FIGURE 1
Semiparametric estimation of average peer effects on heavy-body cognitive bias (nonparametric part).
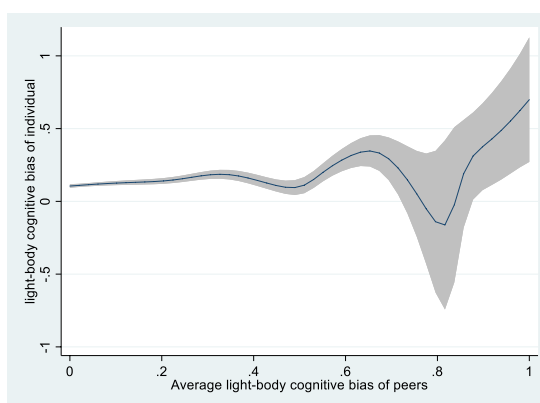

FIGURE 2
Semiparametric estimation of average peer effects on light-body cognitive bias (nonparametric part).

Column 2 and 4 show p-values from the Wald test of exogeneity for peer effects of both body cognitive biases, with original variables considered endogenous, are 0.004 ($p < 0.01$) and 0.039 ($p < 0.05$). Although the IV-Probit two-stage estimation results indicate that the baseline conclusions remain valid ($p < 0.01$).

5.4 Heterogeneity analysis

1. Urban–rural heterogeneity. Children were grouped and regressed by community type to compare peer effects of two body cognitive biases in urban and rural areas. Table 7 shows that light- and heavy-body cognitive biases have significant peer effects in rural areas but not in urban ($p < 0.01$). Hypothesis 2 is valid. According to prior theory, urban and rural communities vary in individual stability, ties density, and daily communication regularity, influencing potential and strength of peer effects.

2. Gender heterogeneity. Group regressions were used to examine gender heterogeneity in the peer effect of two body cognitive biases. Table 8 columns 1 and 3 show that male children are more affected by light-body cognitive biases than females, with a higher coefficient (0.119 > 0.077) and statistical significance. The comparative analysis of columns 1 and 2, as well as columns 3 and 4, reveals that the peer effect is stronger for both heavy- and light-body cognitive biases in female children than males (0.212 > 0.077, 0.160 > 0.119). Hypothesis 3 is valid.

3. Age heterogeneity. The World Health Organization (WHO) categorizes children under 10 as non-adolescents, and those 10 and older as adolescents.[8] Table 9 columns 1 and 2 show that adolescents are more affected by heavy-body cognitive bias than light-body bias (0.144 > 0.131). However, columns 3 and 4 indicate the peer effect of light-body cognitive bias was weaker in adolescents (0.110 < 0.235). Hypothesis 4 is partially valid. This could be attributed to societal aesthetics, emphasizing thinness, significantly influencing children's body perceptions.

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8 http://www.who.int/topics/adolescent_health/en/

TABLE 6 IV-Probit two-stage estimation results.

Variables	Phase I	Phase II	Phase I	Phase II
	Group heavy-body cognitive bias	Heavy-body cognitive bias	Group light-body cognitive bias	Light-body cognitive bias
	(1)	(2)	(3)	(4)
Group heavy-body cognitive bias (lagged one period)	0.141***			
	(5.269)			
Group heavy-body cognitive bias		3.711***		
		(2.612)		
Group light-body cognitive bias (lagged one period)			0.139***	
			(4.956)	
Group light-body cognitive bias				5.346**
				(2.158)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Weak IV test F-value	27.768		24.561	
Exogenous Wald test p-value		0.004		0.039
N	1,344	1,344	1,344	1,344

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$; t-values under robust standard errors are estimated in parentheses in the first stage, and z-values in the second stage.

TABLE 7 Urban−rural grouping regression results.

Variables	Heavy-body cognitive bias		Light-body cognitive bias	
	(1) Urban	(2) Rural	(3) Urban	(4) Rural
Group heavy-body cognitive bias	−0.005	0.163***		
	(−0.081)	(4.210)		
Group light-body cognitive bias			−0.051	0.160***
			(−0.869)	(5.011)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
N	1,323	2,966	1,323	2,966

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$; z-values under robust standard errors are in parentheses.

TABLE 8 Gender grouping regression results.

Variables	Heavy-body cognitive bias		Light-body cognitive bias	
	(1) Male	(2) Female	(3) Male	(4) Female
Group heavy-body cognitive bias	0.077*	0.212***		
	(1.805)	(4.517)		
Group light-body cognitive bias			0.119***	0.160***
			(2.689)	(4.398)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
N	2,275	2014	2,275	2014

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$; z-values under robust standard errors are in parentheses.

TABLE 9 Age grouping regression results.

Variables	Heavy-body cognitive bias		Light-body cognitive bias	
	(1) Adolescence	(2) Non-adolescence	(3) Adolescence	(4) Non-adolescence
Group heavy-body cognitive bias	0.144***	0.131**		
	(3.904)	(2.144)		
Group light-body cognitive bias			0.110***	0.235***
			(3.221)	(3.972)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
N	2,976	1,313	2,976	1,286

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$; z-values under robust standard errors are in parentheses.

TABLE 10 Two types of body cognitive bias and children's body type deviation.

Variables	(1) Normal body	(2) Normal body	(3) Overweight and above	(4) Thin
Light-body cognitive bias	−0.030*		0.257***	
	(−1.923)		(37.362)	
Heavy-body cognitive bias		−0.246***		0.367***
		(−21.659)		(49.830)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
N	4,289	4,289	4,289	4,289

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$; z-values under robust standard errors are in parentheses.

5.5 Further analysis: the health implications of two body cognitive biases

Children's body cognitive biases reduce utility. To counteract this, they use various methods, including food, exercise, and medical techniques, to change body shape (6, 7, 28). Nevertheless, it's uncertain whether Chinese children develop incorrect weight management behaviors due to body cognitive biases. We aim to explore the relationship between body cognitive biases and body size deviation in children.

5.5.1 Whether children's body cognitive bias affects body type

We first examined the relationship between two body cognitive bias and body type deviation, using "whether it deviated from the normal body type" as the dependent variable. Table 10 columns 1 and 2 show that deviation from normal body type increases regardless of form biases. Then, we examined the effects of two body cognitive biases on body type deviation by using "whether or not it tends to be overweight" and "whether or not it tends to be thin" respectively. Columns 3 and 4 show that light-body cognitive bias increases the likelihood of being overweight-obese by 25.7% ($p < 0.01$), and heavy-body cognitive bias increases the likelihood of being thin by 36.7% ($p < 0.01$).

5.5.2 How children's body cognitive bias affects body type

Some literature indicates that body cognition can cause eating disorders (EDs) (6). However, many of them focus on specific foods (1). Changes in calorie intake significantly influence obesity or body leanness, yet the existing literature on body cognition lacks direct evidence. Furthermore, when calorie intake and expenditure change together, it's not certain to cause obesity or weight loss. The literature lacks comprehensive studies on the effects of body cognitive biases on calorie intake and expenditure through the lens of eating and exercise balance.

From "eating-activity balance," we identified how body cognitive biases affect body shape change. Using CHNS data on respondents' average daily calorie intake over the previous 3 days and "Child's average daily caloric intake" as the dependent variable. Left-handed Tobit regression model marginal estimation results are in Table 11 columns 1 and 2. CHNS data also counted children's participation in martial arts, gymnastics, dance, and ball games. Participation in one of these sports was considered sports participation, "child's sports participation" was the dependent variable. Logit regression model marginal estimation results are in columns 3 and 4. Children with a heavy-body cognitive bias reduce calorie intake 37.577 kcal/d ($p < 0.05$) and increase physical activity probability by 2.2% ($p < 0.1$), while children with a light-body cognitive bias, calorie intake increases by 43.557 kcal/d ($p < 0.1$) and physical activity probability by 3.2%

TABLE 11 Body type deviation mechanisms for two types of body cognitive bias.

Variables	Calorie intake		Calorie consumption	
	(1)	(2)	(3)	(4)
Heavy-body cognitive bias	−37.577**		0.022*	
	(−2.239)		(1.834)	
Light-body cognitive bias		43.557*		−0.032**
		(1.846)		(−1.978)
Control variables	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Provincial fixed effects	Yes	Yes	Yes	Yes
Constant term	872.900***	825.058***		
	(6.674)	(6.372)		
N	4,166	4,166	3,940	3,940

$*p < 0.10$, $**p < 0.05$, $***p < 0.01$. The first two columns in parentheses are t-values under robust standard errors, and the last two columns are z-values.

$(p < 0.05)$. Body cognitive biases affect children's "eating-activity balance" and leads to body type deviation. We provide direct evidence, confirming that both calorie intake and expenditure influence the deviation from a healthy body shape caused by body cognitive biases.

6 Discussion and conclusion

6.1 Discussion

This article constitutes the first scholarly investigation into peer effects and health consequences of various body cognitive biases among Chinese children. Body cognitive biases are common among Chinese children, but existing research and policy formulation have not paid enough attention. We have confirmed both light- and heavy-body cognitive biases have peer effects. This support previous research showing that accepting incorrect weight evaluations from peers can directly affect a person's weight development (24). We find that the peer effect is greater in adolescent groups, which is consistent with previous studies showing that adolescents are more susceptible to the influence of perceived peer weight norms (26). Furthermore, our study find the peer effect of body cognitive bias significantly affects children in rural communities, which offer a novel perspective on the documented double-burden of malnutrition faced by rural children in China (52). This corroborates existing literature indicating that unequal health opportunities are intrinsically linked to children' environment (53). Besides, we find that the peer effect of light-body cognitive bias is stronger in girls, while the peer effect of heavy-body cognitive bias is stronger in boys, which once again supports the Gender Schema Theory (40). Previous studies have noted gender disparities in obesity rates among Chinese children (54), our finding suggests that a stronger peer effect of light-body size cognitive bias on boys may be a contributing factor. Finally, we find both light- and heavy-body cognitive biases contribute to deviations from a healthy body shape. The former predisposes children towards obesity, while the latter towards emaciation. Notably, both biases impact calorie intake and consumption. Given the habit formation effect (55), this portends a risk of exacerbated health deterioration in the future and impedes the execution of various health strategies in China.

Limitations include: data constraints prevent us from examining the underlying mechanism of peer effects of two body cognitive biases. Furthermore, while we do confirm the distinct effects of various types of body cognitive biases on children's physical health, it remains unknown whether these biases will have long-term consequences on health status, human capital, and socio-economic standing. Additionally, previous studies have identified an intergenerational transmission effect in mental health (56), which raise the question of whether body cognitive biases may also propagate through generations. This is a potential research topic that warrants future inquiry. Moreover, the dataset used in this article did not cover recent data on cognitive biases in Chinese children. Future research will aim to collect updated data and further discuss the blocking mechanisms of peer effects on children's body cognitive biases.

6.2 Conclusion

Both the light-body cognitive bias and the heavy-body cognitive bias have peer effects in Chinese children, which vary by age, gender, and community characteristics. The former causes children to become overweight by increasing calorie intake and reducing calorie expenditure, while the latter has the opposite effect.

The findings have relevant policy implications: (1) Society should be vigilant and promptly implement effective measures to understand the extent and severity of body cognitive biases among Chinese children; (2) Health, education, and media agencies should collaborate to develop preventive strategies, increase publicity on the risks of body cognitive biases and the benefits of healthy posture, enhance public awareness, and effectively use peer influence to counter unhealthy body image ideologies; (3) Expand the prevention path for overweight, obesity, and malnutrition in Chinese children from the perspective of body cognitive biases.

Data availability statement

Publicly available datasets were analyzed in this study. This data can be found here: https://www.cpc.unc.edu/projects/china.

Author contributions

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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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Check for updates

Helicopter parenting and college student depression: the mediating effect of physical self-esteem

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Background: Depression is one of the most common and prevalent mental disorders, and college students are a high-risk group for depression. Helicopter parenting plays an important role in depression, but the mechanism is still ambiguous. Therefore, this study investigates the specific impact and mechanism of helicopter parenting on college students' depression.

Methods: Employing a questionnaire-based approach, we assessed the relationship between helicopter parenting, Physical self-esteem, and depression. The questionnaire comprised three scales: the Helicopter Parenting Scale, Physical Self-Esteem Scale, and Self-Rating Depression Scale. The study sample included 539 university (average age 18.84 ± 1.1 years; 184 males and 355 females).

Results: Helicopter parenting demonstrated significant negative predict with physical self-esteem ($\beta = -0.75$, $p < 0.001$), and positive predict depression ($\beta = 0.33$, $p < 0.001$). Helicopter parenting impacts depression among college students through two channels: solely via physical self-esteem (mediating effect value: 0.66), and through direct influence (effect value: 0.64).

Conclusion: The insights from this study address the two pivotal questions about "why" and "how" helicopter parenting influences depression in college students, offering recommendations for managing depressive moods among college students.

1 Introduction

The concept of "helicopter parenting," which originated in Western societies, refers to a style of over-involved parenting, where parents excessively intervene in the lives of their young adult children (1). This style is often marked by heightened behavioral control and undue restrictions on children's autonomy (2). Although helicopter parenting aims to promote children's success, it may paradoxically increase the risk to their psychological health (3–5). This trend of parenting is becoming increasingly common in China (2, 6–8), where the one-child policy, a fundamental element of China's traditional family structure, has intensified

parental scrutiny and expectations on the only child, leading to a unique cultural adaptation of helicopter parenting (9, 10). The growing phenomenon of helicopter parenting in China calls for an in-depth exploration of its effects, especially considering its potential to initiate or worsen mental health issues.

Amidst the mounting concern for psychological well-being, depression emerges as a critical issue closely entwined with the parenting styles prevalent in society (11–13). College students, already navigating the tumultuous transition from adolescence to adulthood, confront additional stressors that may be exacerbated by overbearing parental involvement. This is evidenced by the alarming statistics revealing that 24.71% of Chinese college students exhibit depressive symptoms. This figure mirrors the increasing prevalence of over-parenting and is continuing to rise (14). These stressors, ranging from academic pressure to the challenges of environmental adaptation and future planning, place college students at heightened risk for depression (15, 16), a condition that not only impairs cognitive functions and executive capacity but also predisposes them to social withdrawal and suicidality (17). Therefore, it becomes especially urgent and important to deeply study the mechanisms between helicopter parenting and college students' depression.

1.1 Helicopter parenting and college students' depression

According to the Social-Ecological Systems Theory, individuals are situated within specific environmental systems, and individual psychological development is the result of continuous interaction with the social environmental system (18). Among these environmental systems, the family environment, is the earliest growth setting for individuals (19). Further, the parenting style within the family environment is one of the most direct and closely related influencing factors during an individual's growth process, having a long-term and progressive impact on psychological health (14). Existing research indicates that depression is not innate, and parenting style plays a significant role in influencing depression (20). Specifically, parents who encourage autonomy allow their children to explore interests and minimize control and pressure to the greatest extent, which helps inhibit the development of depressive feelings (21). However, if parents adopt controlling methods (e.g., decision interference, deprivation, and supervision) to guide their children's behavior, these children will experience reduced autonomy, leading to an accumulation of depressive emotions (22). Based on this, the influence of parenting styles on college students' depression should not be underestimated.

Recent studies have underlined the link between helicopter parenting and depression in young adults, with heightened parental involvement potentially leading to feelings of isolation among this demographic (20). This isolation may, in turn, influence young adults to attribute their life outcomes to external factors, such as luck or opportunity, rather than their efforts and abilities (23). Such external attribution is known to exacerbate depressive feelings when facing life's challenges (24). Supporting this, research has consistently found a significant relationship between helicopter parenting and the emergence of neurotic traits that are closely associated with depression (25, 26). Additionally, there is a body of evidence indicating that individuals raised by helicopter parents have a higher propensity to use antidepressant medications (7). Based on these insights, this study hypothesizes that helicopter parenting will predict depression in college students (Hypothesis 1).

1.2 The mediating role of physical self-esteem

Self-determination theory posits that the fulfillment of basic psychological needs for autonomy, competence, and relatedness is vital for an individual's well-being (27). Helicopter parenting, characterized by intrusive and controlling behaviors, can undermine these needs by impeding students' autonomy and hampering the development of competence. This encroachment may lead to diminished physical self-esteem, as students' confidence in their body image and physical capabilities—an intrinsic aspect of the need for competence—becomes compromised (28). Furthermore, low physical self-esteem can foster a negative self-concept, a well-established precursor to depressive symptoms (29). Given these insights, it invites consideration that physical self-esteem might play a mediating role in how helicopter parenting affects depression in college students, suggesting a nuanced pathway that warrants further exploration.

Building on this theoretical foundation, physical self-esteem stands as a core component of overall self-esteem and begins to take shape early in one's self-awareness development. It reflects an individual's self-perception and valuation of their appearance and physical abilities (30). Evidence suggests that physical self-esteem plays a significant role in regulating depression levels, with those possessing higher physical self-esteem more likely to utilize support networks effectively in the face of adversity (31, 32). These support mechanisms can help alleviate stress and enhance adaptability, potentially curbing the development of depressive symptoms (33). Conversely, low physical self-esteem may lead to a decline in coping effectiveness, increasing susceptibility to mental distress and the accumulation of depressive feelings. As such, this study posits that physical self-esteem may predict the presence of depression in college students (Hypothesis 2).

While prior research has focused on the relationship between helicopter parenting and general self-esteem (22), the specific impact of such parenting on physical self-worth remains underexplored. The Social Comparison Theory complements the Self-Determination Theory by suggesting that individuals form their self-perceptions by comparing themselves to their peers (34). Positive parenting styles that foster autonomy can enhance physical self-esteem as individuals affirm their control in these comparisons (35). However, helicopter parenting, by restricting autonomy and emphasizing success, may negatively influence this process. The detrimental effects of helicopter parenting on autonomy and subsequent physical self-worth become even more pronounced when viewed through the lens of comparative self-evaluation, potentially diminishing an individual's physical self-esteem (36). In light of these considerations, this study hypothesizes that physical self-esteem will function as a mediating variable, linking helicopter parenting with college students' depression (Hypothesis 3).

In summary, this study endeavors to articulate a comprehensive mediation model (Figure 1) that disentangles the nuanced mechanisms between helicopter parenting and depression in college students, with physical self-esteem serving as a pivotal mediating factor.
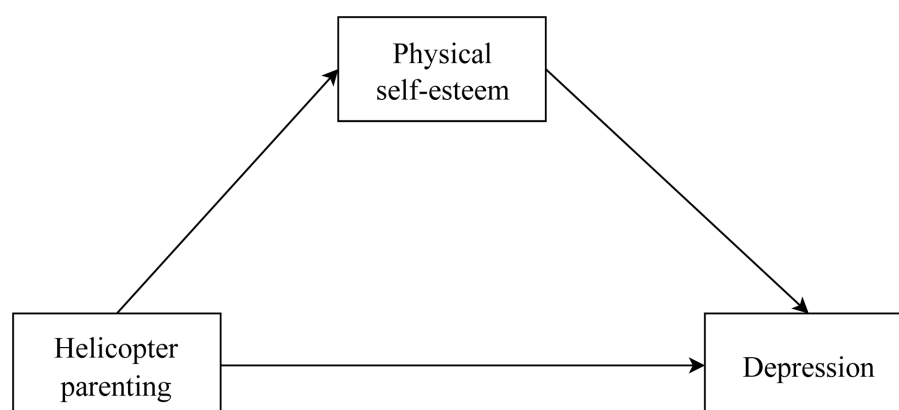
FIGURE 1
Mediation hypothesis model.

2 Research methods

2.1 Participants

Utilizing convenience cluster sampling, this study selected 600 undergraduates from 20 classes across four universities in China. The data collection was conducted in May 2023. Participants were required to complete offline paper questionnaires. Before the survey, an "Informed Consent Form for Survey" was distributed, ensuring that consent was obtained from participants who were informed about and agreed to participate in the study. Standardized instructions were provided on-site, detailing necessary precautions and emphasizing the principles of voluntary participation and the confidentiality of the survey responses.

Under the supervision of research assistants, participants filled out the paper questionnaires based on their true conditions, ensuring the integrity and accuracy of the data collection process. Each student completed three questionnaires: the "Helicopter Parenting Scale," the "Physical Self-Esteem Scale," and the "Depression Self-Assessment Scale." Out of the 594 individuals who agreed to participate and completed the survey, 55 invalid questionnaires were excluded (11 blank, 20 with missing answers, and 24 with patterned answers), resulting in 539 valid questionnaires. The demographic composition of the valid responses included an average age of 18.84 ± 1.1 years, comprising 184 males and 355 females. The effective response rate was 90.74%. The questionnaire completion process took approximately 15 min for each participant.

2.2 Measures

2.2.1 Helicopter parenting

The helicopter parenting scale, originally developed by Padilla-Walker et al. (1) and later revised by Lin (6), was employed to gage the extent of helicopter parenting experienced by students in China. The scale consists of 5 test items, for example, "My parents make crucial decisions for me, like where I should live, work, or the courses I should enroll in." The scale uses a 5-point scoring system, with 1 being "completely disagree" and 5 being "completely agree." A higher score

indicates a higher level of helicopter parenting experienced by the college student. In the original validation study by Padilla-Walker et al. (1), the Cronbach's α coefficient was reported as 0.77, and the Cronbach's α coefficient in this study is 0.715, indicating a consistent reliability across different contexts.

2.2.2 Physical self-esteem

The Physical Self-Perception Profile (PSPP), originally developed by Fox and Corbin (37) and later revised by Xu and Yao (38), was employed to measure the physical self-esteem of students in China. The scale consists of 30 test items, encompassing five dimensions: athletic competence, physical condition, body condition, self-worth, and physical attractiveness. For example, "I think it's easy for me to keep my body attractive." The scale uses a 4-point scoring system, with 1 being "strongly disagree" and 4 being "strongly agree." A higher score indicates a higher level of physical self-esteem among college students. In the original validation study by Fox and Corbin (37), the Cronbach's α coefficient was reported as 0.92, and the Cronbach's α coefficient of this study is 0.967, indicating a consistent reliability across different contexts.

2.2.3 Depression

The Self-Rating Depression Scale (SDS) was originally developed by Zung (39) and later revised by Yuan et al. (40) to assess depression in China. The scale consists of 20 test items, covering four dimensions: psychological-affective symptoms, somatic disturbances, psychomotor disturbances, and psychological impediments of depression. For example, "I feel useful and indispensable." The scale uses a 4-point scoring system, with 1 being "strongly disagree" and 4 being "strongly agree." A higher score indicates a higher frequency of depressive symptoms in the college student. In the original validation study by Zung (39), the Cronbach's α coefficient was reported as 0.79 (41), and the Cronbach's α coefficient of this study is 0.794, indicating a consistent reliability across different contexts.

2.2.4 Personal demographics

Research suggests that personal demographics such as gender, age, and family socioeconomic status can significantly impact parenting styles and depression (42, 43). Building upon this foundation, the

present study incorporates findings from Qu (44) and Ge (45) concerning Chinese college students. Essential personal information—like gender, age, annual household income, and the educational levels of both parents, as well as perceived family social class—was gathered to control potential confounding variables. A higher score relating to annual household income, parents' education levels, and perceived family social class denotes a higher standing in those respective domains.

2.3 Statistical analysis

In this study, we conducted statistical analyses using SPSS 25 for Windows 10. The analysis accounted for missing data, which were minimal and did not significantly impact the overall dataset. The missing values were imputed using multiple imputation techniques. Sum scores for all measures were computed to investigate the research questions and to assess the hypothesized relationships among variables. Initially, a Harman single-factor test, following Zhou and Long's (46) guidelines, was applied to address and evaluate potential common method bias. This was succeeded by an examination of the inter-variable relationships using Pearson correlation coefficients, which laid the groundwork for understanding the dynamics between helicopter parenting, physical self-esteem, and depression.

We then progressed to regression analysis, employing Model 4 of PROCESS macro, to discern the direct effects and to scrutinize both simple and mediated relationships present in the data (13). To rigorously evaluate the mediation effects, we used the bias-corrected non-parametric percentile Bootstrap method. This sophisticated approach allowed for the creation of a sampling distribution of indirect effects, leading to the construction of confidence intervals for the mediation effect size (47). Each stage of analysis was carefully chosen and conducted with the aim of thoroughly examining the data and precisely validating the theoretical framework proposed by this research.

3 Results

3.1 Common method bias test

In the present study, measures were taken to address potential common method bias by employing anonymous surveys and incorporating reverse coding for particular items, as suggested by Zhou and Long (46). To further evaluate the presence of common method bias, a Harman single-factor analysis was conducted using SPSS 25.0. The analysis revealed eleven factors with eigenvalues surpassing 1. Notably, the principal factor accounted for only 31.65% of the variance, falling short of the critical 40% threshold. Thus, it can be concluded that this research was not influenced by common method bias.

3.2 The correlation between the study variables

This study utilized SPSS 25.0's Pearson correlation test to compute the mean, standard deviation, and correlations of various variables. As

the main results are shown in Table 1, the correlation of helicopter parenting was negatively related to physical self-esteem ($r = -0.76$, $p < 0.001$) and gender ($r = -0.12$, $p < 0.001$), positively related to depression ($r = 0.68$, $p = 0.012$). The correlation of physical self-esteem was negatively related to physical self-esteem ($r = -0.76$, $p < 0.001$), depression ($r = -0.71$, $p < 0.001$), and mother's education level ($r = -0.09$, $p = 0.032$). The correlation of depression was negatively related to physical self-esteem ($r = -0.71$, $p < 0.001$), and positively related to helicopter parenting ($r = 0.68$, $p < 0.001$). However, the correlation of family socioeconomic status was not related to helicopter parenting and depression ($p > 0.05$), but gender was negatively related to helicopter parenting ($r = -0.12$, $p = 0.018$).

3.3 The regression analysis

Based on the mediation testing method by Wen and Ye (2014), this research used Model 4 in SPSS plugin PROCESS (13), with helicopter parenting as the independent variable, depression as the dependent variable, physical self-esteem as the mediating variable, and gender, age, annual household income, father's education level, mother's education level, and subjective family social class were taken as control variables. The results of the regression analysis are shown in Table 2. Specifically, Model 1 was constructed to examine the impact of helicopter parenting on physical self-esteem. The results indicated that helicopter parenting negatively predicted physical self-esteem ($\beta = -0.75$, $p < 0.001$). This suggests that higher levels of helicopter parenting are associated with lower levels of physical self-esteem among college students. However, Model 1 accounted for 56% of the variance in physical self-esteem, with an F-statistic of 84.95, denoting that the model was a good fit for the data.

In Model 2, the direct relationship between physical self-esteem and depression was examined alongside the role of helicopter parenting. Here, physical self-esteem negatively predicted depression ($\beta = -0.46$, $p < 0.001$), indicating that higher physical self-esteem is associated with lower depression scores. Additionally, helicopter parenting positively predicted depression ($\beta = 0.33$, $p < 0.001$), suggesting that more helicopter parenting is correlated with higher levels of depression, supporting hypothesis 2. However, Model 2 explained 58% of the variance in depression, with an F-statistic of 108.14, confirming the model's strong explanatory power. Concurrently, it was found that all the standardized path coefficients in the model were significant (Figure 2).

3.4 The mediating effect analysis

This study applied the bias-corrected non-parametric percentile Bootstrap method, entailing 5,000 resamples, to rigorously assess the mediation effects. All tests of statistical significance were conducted with an alpha level set at 0.05. The results, detailed in Table 3, include 95% confidence intervals for the indirect effects, offering a precise estimation of the effect sizes and affirming the reliability of the mediation analysis. Specifically, a significant indirect effect of helicopter parenting on depression via physical self-esteem, evidenced by an effect size of 0.66 and a 95% CI [0.49, 0.84], which accounted for 50.15% of the total effect. The direct effect of helicopter parenting on depression was also notable at 0.64 (95% CI [0.47, 0.80]), contributing

TABLE 1 Descriptive statistics and interrelations among all observed variables.

Variables	M	SD	1	2	3	4	5	6	7	8	9
1. Helicopter parenting	12.85	7.1	1								
2. Physical self-esteem	76.97	6.03	−0.76***	1							
3. Depression	55.41	12.38	0.68***	−0.71***	1						
4. Gender	0.34	0.47	−0.12**	0.12**	−0.07	1					
5. Age	18.84	1.10	0.00	0.02	0.00	0.07	1				
6. Annual household income	4.31	1.53	−0.04	0.05	−0.06	0.04	0.08	1			
7. Father's education level	2.87	1.16	0.04	−0.02	0.00	−0.03	0.07	0.27***	1		
8. Mother's education level	2.65	1.21	0.06	−0.09*	0.04	−0.09*	0.01	0.24***	0.61***	1	
9. Subjective family social class	2.40	0.77	−0.07	0.07	−0.07	−0.04	−0.01	0.30***	0.36***	0.35***	1

***$p < 0.001$; **$p < 0.005$; *$p < 0.05$.

TABLE 2 The mediation model from helicopter parenting to depression.

	Model 1			Model 2		
	Physical self-esteem			Depression		
	β	SE	t	β	SE	t
Helicopter parenting	−0.75	0.14	9.46***	0.33	0.08	7.51***
Body self-esteem				−0.46	0.01	−10.38***
R^2	0.56			0.58		
F	84.95			108.14		

***$p < 0.001$.

TABLE 3 Bootstrap mediating effects of helicopter parenting and depression.

Paths	Effect	BootSE	95%CI		Relative mediating effect
Total effect	1.31	0.06	1.19	1.43	100%
Direct effect	0.64	0.08	0.47	0.80	48.85%
Indirect effect	0.66	0.08	0.49	0.84	50.15%

Total effect: Direct effect + Indirect effect; Direct effect: Helicopter parenting → Depression; Indirect effect: Helicopter parenting → Physical self-esteem → Depression.

48.85% to the total effect. The non-inclusion of zero in the 95% confidence intervals across all pathways confirms the significant mediation effect, thereby supporting Hypothesis 3.

4 Discussion

In this study, we constructed a structural model encompassing helicopter parenting, physical self-esteem, and depression. The model posits that while helicopter parenting has a direct impact on depression, physical self-esteem mediates the relationship between helicopter parenting and depression. The findings corroborated Hypotheses 1–3, enriching our comprehension of how helicopter parenting affects college students' depressive symptoms. Such insights offer empirical grounding for future interventions.

4.1 Helicopter parenting and depression

The results of this study indicate that helicopter parenting positively predicts depression, corroborating hypothesis 1. This observation is consistent with prior research (48, 49), bolstering the tenets of the social-ecological theory. Within the family system, parenting styles play a pivotal role in shaping an individual's psychological well-being (35, 36). Past studies have also highlighted achievement anxiety and diminished autonomy as notable precursors to depression (50). Given that helicopter parenting is typified by undue protection and control, it stifles individual autonomy and a sense of achievement (51). Consequently, helicopter parenting stands out as a salient predictor of depression.

Notably, when comparing the correlation coefficients between helicopter parenting and depression among college students in previous research, this study exhibits certain disparities. Schiffrin et al. (26) reported a value of 0.27, Turner et al. (52) found 0.2, and Cook (53) documented 0.12. In contrast, this study yielded a higher coefficient of 0.68. Such variation can likely be attributed to distinct cultural and national contexts. Although China has loosened its one-child policy, its enduring legacy means many families have a single child. Even when attending college away from home, students may still experience helicopter parenting, perhaps through distant communication (54). Additionally, rooted Confucian values emphasize filial piety and reverence for elders, potentially leading
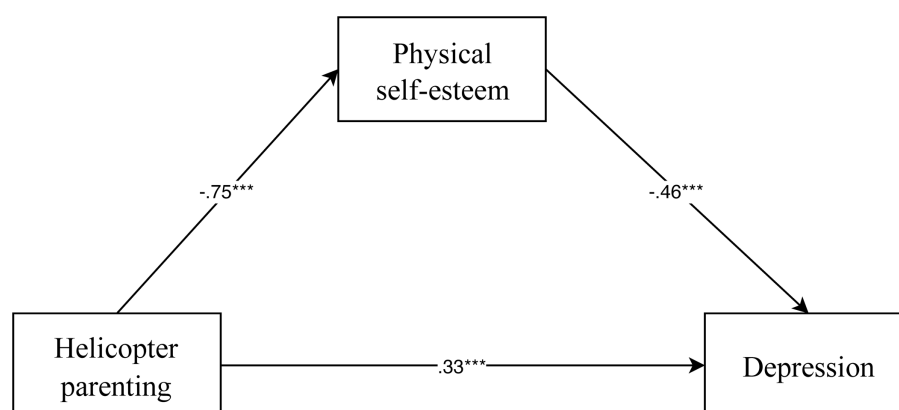
FIGURE 2
Model of the mediated role of physical self-esteem in the relationship between helicopter parenting and depression.

parents to express heightened concern about their children's growth and academics (55). This concern may evolve into the overprotection synonymous with helicopter parenting. Conversely, in Western cultures, the emphasis on individual autonomy may prompt parents to grant their children more freedom, minimizing their controlling tendencies. By delving into the context of Chinese education, this study broadens the applicability of the social-ecological framework. Moreover, the results underscore the potential merit of refining parenting techniques to prevent the onset of depressive symptoms in young adults.

4.2 The mediating role of physical self-esteem

This study substantiated the predictive nature of physical self-esteem on depression among college students, while also affirming its mediating role between helicopter parenting and such depression. Both Hypotheses 2 and 3 were supported. This aligns, in part, with prior empirical findings (28), corroborating the social comparison theory (34). Historically, physical self-esteem has been recognized as a significant predictor of depression (56). Furthermore, in a 16-week study by He and Ji (28), a causative link was identified between individual physical self-esteem and their depression levels. This research further delves into the precursors of physical self-esteem fluctuations. Specifically, individuals tend to assess their capacities and accomplishments through comparison with others. The nature of helicopter parenting may inadvertently compel children to engage excessively in such comparisons, overshadowing their individual growth (57). Consequently, this predisposes them to negative self-assessments regarding physical competencies and appearance, undermining their physical self-worth. Moreover, influenced by helicopter parenting, students with diminished physical self-esteem may gravitate towards unproductive coping mechanisms like self-devaluation and avoidance when confronted with stressors, culminating in depressive sentiments (24).

Within the sphere of helicopter parenting, parents' pronounced control often infringes on an individual's autonomy, channeling much of their focus into academics and comparable endeavors. This not only

directly heightens college students' susceptibility to depression but also inadvertently diminishes their physical self-esteem during self-comparisons (50, 58), further exacerbating depression. In summation, this study's mediation model provides an elucidated understanding of the intricate processes by which helicopter parenting modulates college students' depression levels.

4.3 Limitations and future direction

This research utilized a cross-sectional study design, which facilitated the identification of relationships among the variables under examination, thereby laying the groundwork for future empirical investigations. Nonetheless, to ascertain causality among these variables, embarking on a longitudinal experimental approach would be indispensable. Additionally, our data collection hinged predominantly on self-reported measures. Although this method provided a foundational perspective, it is paramount for subsequent studies to employ more objective means. While the crux of this study was the exploration of physical self-esteem as a mediator between helicopter parenting and depression in college students, it is pertinent to acknowledge the potential significance of other mediatory factors. Variables such as self-efficacy, self-awareness, and overall physical health could be pivotal in this dynamic, thereby heralding fresh avenues for future inquiries.

5 Conclusion

Upon surveying 539 college students, our research demystified the intricate relationship between helicopter parenting, physical self-esteem, and depression. We observed a pronounced positive relationship between helicopter parenting and depression and a discernible negative tie with physical self-esteem. Moreover, helicopter parenting did not show any substantial association with family socio-economic status. Our findings suggest that helicopter parenting could indeed forecast variations in physical self-esteem and depression levels. Crucially, physical self-esteem stood out as a mediating factor, elucidating the connection between helicopter parenting and

depression in college students. This study not only deciphers the underpinnings of how and why helicopter parenting impacts depression in college students but also propounds actionable guidelines for interventions aiming to ameliorate depressive states in this demographic.

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 Ethics Committee of the Hunan Normal University. The patients/participants provided their written informed consent to participate in this study.

Author contributions

CW: Conceptualization, Investigation, Project administration, Supervision, Validation, Writing – original draft. HS: Conceptualization, Data curation, Investigation, Project administration, Supervision, Validation, Visualization, Writing – original draft. GL: Data curation, Formal analysis, Methodology, Resources, Software, Validation, Writing – original draft.

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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The relationship between major life events and non-suicidal self-injury among college students: the effect of rumination and body image

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Background: Non-suicidal self-injury (NSSI) poses a growing risk to public health worldwide. While numerous studies have identified major life events as key risk factors for NSSI, the mechanisms by which emotional and cognitive problems mediate or moderate this relationship remain unclear. To enhance the understanding of this field, we will draw upon the cascade theory of self-injury and the benefits and barriers model, to examine the relationship between major life events and NSSI, as well as the effect of rumination and body image.

Methods: A sample of 2,717 college students (M_{age} = 19.81 years; SD = 1.09) participated in this study and anonymously completed the questionnaires. The moderated mediation model were conducted using Model 4 and Model 15 of the Process macro program in SPSS.

Results: The results showed that rumination mediated the positive relationship between major life events and NSSI. Furthermore, body image was found to moderate both the relationship between major life events and NSSI, as well as the relationship between rumination and NSSI.

Conclusion: The current findings suggest that rumination is an important mediator in the relationship between major life events and NSSI among college students. Teachers, parents, and researchers should recognize the important role of body image self-perceptions of college students and actively promote a healthy and accurate body image.

1 Introduction

Non-suicidal self-injury (NSSI) is frequently acknowledged to be common in adolescence (10–24 years old) (1, 2). In recent years, NSSI among adolescents has emerged as a major global public health concern (3). Non-suicidal self-injury refers to an intentional and self-injurious behavior that is not accompanied by suicide ideation and is not socially acceptable. The common expressions of NSSI encompass self-inflicted actions

such as cutting, burning, and scratching (4). The mentioned behavior often occurs in adolescents and young adults and has the potential to cause serious harm to their physical and mental well-being (5). Research studies showed that 17.7% of college students have engaged in NSSI on at least one occasion throughout their lifetime (6). Meanwhile, in China, a nationally representative sample of over 150,000 adolescents noted that 13.4% of the participants had engaged in NSSI at least three or more times within a single year (7). Non-suicidal self-injury is an important risk factor for adolescent suicide, with one study noting that adolescents who engaged in NSSI were associated with an increase of 17 times in suicide behavior than their counterparts who did not engage in NSSI (8). Hence, it is crucial to improve understanding of the causes and potential mechanisms underlying NSSI in order to promote the mental well-being of adolescents and college students.

Major life events refer to a range of significant events that occurred in the lives of adolescents within the preceding year, potentially having a substantial impact on them (9). These events cover a variety of experiences, including traumatic experiences, loss, and major transitions (10). Research showed that major life events have been identified as important risk factors for NSSI. When individuals are exposed to major life events, they will develop more negative emotions and use poor coping styles when the emotions are not resolved; negative life events are the trigger for negative emotions and risky behaviors in individuals (11). At the same time, the experiential avoidance theory posits that individuals who experience negative emotions when confronted with negative events are especially susceptible to engaging in NSSI. To avoid these negative emotions, individuals often choose to engage in NSSI as a way of attaining immediate emotional relief and avoiding the unpleasant experience (12). Additionally, a longitudinal study consisting of three waves of data indicated that major life events at T1 were found to have a direct impact on the occurrence of NSSI at T3 (13). In recent years, numerous studies have explored the effects of NSSI on various psychological factors, such as depression (14), anxiety (15), and cyberbullying (16). These studies have contributed to our understanding of NSSI. Nevertheless, the specific mediating and moderating mechanisms of this phenomenon remain unclear and need to be further investigated.

Rumination, a maladaptive cognitive process characterized by the repetitive and intrusive thought of negative experiences (17), was thought to be a key cognitive process in maintaining NSSI (18). The emotional cascade theory about NSSI pointed out that when an individual is exposed to an adverse event, they are prone to the presence of high arousal negative emotions. This high arousal negative emotion will continue to fester in the human brain and cannot be released, thus allowing rumination to occur, and when rumination reaches a certain level and the individual is unable to cope with the psychological pain, they will relieve themselves of the psychological pain with the immediately available NSSI (physiological pain), thereby increasing the likelihood of engaging in NSSI (19). According to emotion appraisal theory, emotions arise from interpretations and explanations of the environment of people in which they find themselves. According to Richard Lazarus, there are two main types of reactions to major life events: automatic, unconscious, and rapidly activated emotional responses, and

conscious emotional responses related to how to cope, such as rumination (20). A longitudinal study that included 1,065 samples noted that major life events can predict rumination, while rumination played an important mediating role in the relationship between major life events and mood problems (depression and anxiety) (21). Numerous studies have indicated a significant positive relationship between rumination and NSSI among college students (22, 23). Furthermore, a meta-analysis included 46 studies additionally demonstrated that rumination exerted a significant influence on NSSI (24). Although numerous studies have pointed out that emotions mediate the relationship between major life events and NSSI (25). There is a limited body of research that examines the role of rumination, which encompasses negative emotions and cognitive functioning, in the relationship between major life events and NSSI. Thus, we hypothesize that rumination mediated the relationship between major life events and NSSI in college students.

In addition, the benefits and barriers model of NSSI pointed out that Body Perceptions for Identity are a significant barrier to NSSI and serve as an important protective role (26). Body image refers to an individual's subjective perception of the esthetic or sexual appeal of their own body. It places greater emphasis on self-perception of individuals rather than conforming to social standards (27) and serves as a fundamental element of self-identity (28). Individuals with high body intention toward their physical appearance are more likely to develop a strong attachment to their bodies while also being less likely to engage in NSSI (29). This theory suggests that having a positive body image may be an important protective factor in the development of NSSI problems. This protective function is believed to moderate the effects of adverse experiences and negative emotions on NSSI. Research has been indicated that body image can moderate the relationship between emotional maladjustment and NSSI. However, there is a lack of research to validate whether body intention moderates the relationship between major life events and NSSI, as well as the relationship between rumination and NSSI (30). We therefore hypothesize that body image can moderate the relationship between major life events and NSSI, as well as the relationship between rumination and NSSI. However, the specifics of the moderating effect need to be further validated.

In summary, the present study aims to further explore whether the relationship between major life events and NSSI is mediated by rumination. This examination is based on the emotional cascade theory of NSSI and Hooley and Franklin's benefit and barrier theory. Additionally, this study aims to explore whether the relationship between rumination and NSSI and the relationship between major life events and NSSI are all moderated by body image. The hypothesized diagram of the model for this study is shown in Figure 1, and we propose the following three hypotheses:

Hypothesis 1: Major life events are positively related to NSSI.

Hypothesis 2: Rumination mediated the relationship between major life events and NSSI.

Hypothesis 3: Body image moderated the relationship between major life events and NSSI, as well as the relationship between rumination and NSSI.
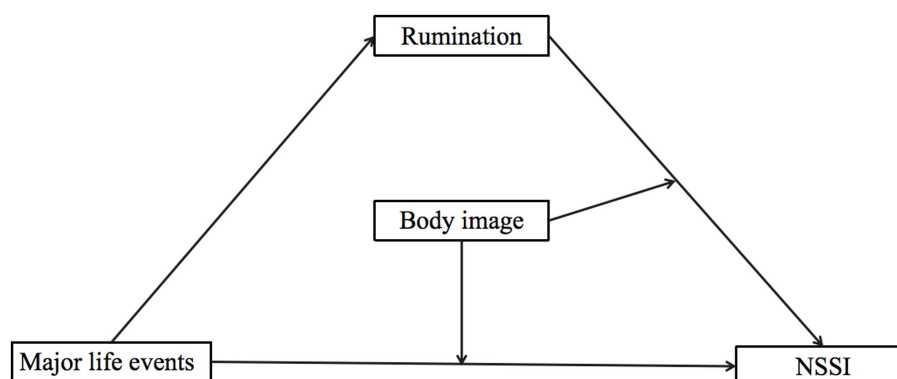
FIGURE 1
Hypothesis model.

2 Methods

2.1 Participants and procedure

A convenience sampling method was used to recruit 2,992 college students from a college located in southern China. All participants completed the questionnaires anonymously and received a detailed mental health report upon completion of the questionnaires. The questionnaires were distributed using the Questionnaire Star platform.[1] Students can complete the questionnaires by scanning a QR code with their mobile devices or by accessing a link on their computers. Several measures were implemented to ensure the quality of the questionnaire. For example, for a fixed-option lie-detecting question, choose C for this question, answer time limited and so on. Blank options, answer time less than 8 min, and outliers were excluded from the final dataset. Ultimately, 2,717 valid questionnaires were collected, with an effective recovery rate of 90.81%. This study was approved by the Ethics Committee of the School of Psychology, South China Normal University, with the assigned ethical approval number SCNU-PSY-2022-217. All participants provided their informed consent by signing a consent form and were informed of their right to withdraw from the study at any time.

2.2 Measures

2.2.1 Major life events

Major life events were measured using the Adolescent Self Rating Life Events Checklist compiled by Liu et al. (31) and subsequently revised by Li et al. (9). This checklist employed a six-point Likert-type scale ranging from 0 (did not occur) to 5 (did occur and there was heavy impact). A total of 16 items were included in the checklist, which assessed the stressors experienced by college students in various domains, including school, family, interpersonal, and personal factors. Examples of stressors included "conflicts or fights with classmates or close friends." The total score was calculated by summing the

responses to all items. Higher scores on the checklist indicated that the subjects suffered from more serious major life events. The scale had a good internal consistency with Cronbach's alpha of 0.870.

2.2.2 Non-suicidal self-injury

The non-suicidal self-injury was assessed using the Inventory of Statements about Self-harm (ISAS), a scale developed by Klonsky et al. (32) and translated by You et al. (33). This self-report inventory utilizes a six-point Likert-type scale to assess the severity of NSSI. It assesses the frequency of NSSI occurrences within the past year. The severity of NSSI among college students was assessed by inquiring about the frequency of engaging in 12 distinct methods of self-harm in the past year, e.g., intentionally injuring themselves with a fist, slap, or harder objects. In the given scale, where numerical values ranging from 0 to 5, the total score on the scale serves as an indicator of the severity of self-injurious behaviors, with higher scores representing more severe self-injury among college students. Cronbach's alpha for the scale was 0.845.

2.2.3 Rumination

Rumination was measured using the Ruminative Response Scale (RRS) developed by Nolen-Hoeksema et al. in 1991 (34) and further revised by Han et al. (35). The questionnaire consists of 22 items, with one example question being "I always think about a recent situation, wishing it had gone better." The scale is assessed using a four-point Likert-type scale, ranging from 1 (never) to 4 (always), with the overall score being calculated. The higher score on the scale represents the more serious tendency of the rumination thinking of college students. The scale had a good internal consistency with Cronbach's alpha of 0.974.

2.2.4 Body image

Perceptions of body image of college students were measured using the Body Image State Scale (BISS) developed by Cash et al. (27) and translated and revised by Wang et al. (36) into Chinese version. The scale consists of six items, such as "how I feel about my body type at this moment" and "how I feel I look compared to the average person." The scale is a nine-point Likert scale ranging from 1 (extremely dissatisfied) to 9 (extremely satisfied). The total score of the scale was calculated. Higher scores on the scale exhibited that the

individuals have greater satisfaction with their body feelings and a more positive body image. The scale had a good internal consistency with Cronbach's alpha of 0.973.

2.3 Covariates

This study incorporates demographic variables as covariates for analysis, which have been identified in previous research as possible predictors of the study outcomes (22), including gender, age, ethnicity, place of residence, subjective economic status, only child, history of mental illness, history of smoking, history of alcohol consumption, history of relationships, and somatic symptoms.

2.4 Statistical analysis

SPSS 26.0 was used for the initial analysis of the data and covariance test, and the data were tested for common method bias using Harman's one-way test. The main variables were then tested for correlation using Spearman correlation analysis. The data were standardized for the main variables, and then the model was built and validated using Hayes' PROCESS 4.0 plug-in, with Hypotheses 1 and 2 being tested by the mediated model (Model 4) and Hypothesis 3 being tested by the moderated mediation model (Model 15). While the bias-corrected nonparametric percentile Bootstrap methods was used to test the moderated mediation effect and estimate the 95% confidence interval with 5000 repetitions.

3 Results

3.1 Collinearity test

The variance inflation factor (VIF) of all predictive variables (1.078–1.353) was less than 3, and tolerance (0.739–0.928) was greater than 0.1, indicating that there is no serious multicollinearity in date (37).

3.2 Common method bias

To control the problem of common method bias, this study used the Harman one-way test for common method bias. The results showed that there were eight common factors were greater than 1. The unrotated first factor explained only 30.55% of the total variance and did not account for 40% of the total variance explained. This indicates that there is no significant common method bias in the data of this study.

3.3 Characteristics of the participants

As shown in Table 1, 2,717 college students were included in this study, 611 individuals (22.49%) were male, 1,050 individuals (38.65%) resided in cities, and 367 individuals (13.51%) were only child. The prevalence of non-suicidal self-injury (NSSI) among college students was found to be 11.56%.

TABLE 1 Demographic characteristics of the sample.

Variable	N = 2,717	
Gender, n (%)		
Male	611	(22.49)
Female	2,106	(77.51)
Age, M (IQR)	19.81	(1.09)
Ethnicity, n (%)		
Han*	2,661	(97.94)
Minority	56	(2.06)
Place of residence, n (%)		
City	1,050	(38.65)
Rural	1,667	(61.35)
Economic status, n (%)		
Much better	41	(2.51)
Better	250	(9.20)
Similar	1,428	(52.56)
Worse	778	(28.63)
Much worse	220	(8.10)
Only child, n (%)		
Yes	367	(13.51)
No	2,350	(86.49)
History of mental illness, n (%)		
Yes	30	(1.10)
No	2,687	(98.90)
History of smoking, n (%)		
Never	2,537	(93.37)
Past	95	(3.50)
Present	85	(3.13)
History of alcohol consumption, n (%)		
Never	2,171	(79.90)
Past	180	(6.63)
Present	366	(13.47)
History of romantic relationships, n (%)		
Never	1,324	(48.73)
Previous	745	(27.42)
Present	648	(23.85)
Somatic symptoms, n (%)		
Yes	787	(28.97)
No	1930	(71.03)

*In China, the Chinese population is composed of 56 ethnic groups, known as Minzu, with the Han ethnic group (Han Zu) being the largest, accounting for 92% of the total population.

3.4 Descriptive analysis and correlation test of scale scores

Descriptive statistics and Spearman's correlation analysis were performed for the main variables. As shown in Table 2, the results indicated that major life events were positively related to rumination ($r = 0.52$, $p < 0.001$) and NSSI ($r = 0.24$, $p < 0.001$), and rumination also showed a positive correlation with NSSI ($r = 0.31$, $p < 0.001$).

TABLE 2 Descriptive statistics and correlation between the main variables ($N = 2,717$).

Variables	$M \pm SD$	1	2	3	4
1 Major life events	7.48 ± 8.57	—			
2 Rumination	34.94 ± 13.12	0.52***	—		
3 Non-suicidal self-injury	0.73 ± 3.42	0.24***	0.31***	—	
4 Body Image	31.02 ± 10.22	−0.22***	−0.29***	−0.18***	—

***$p < 0.001$.

FIGURE 2
Mediation model (Model 4).
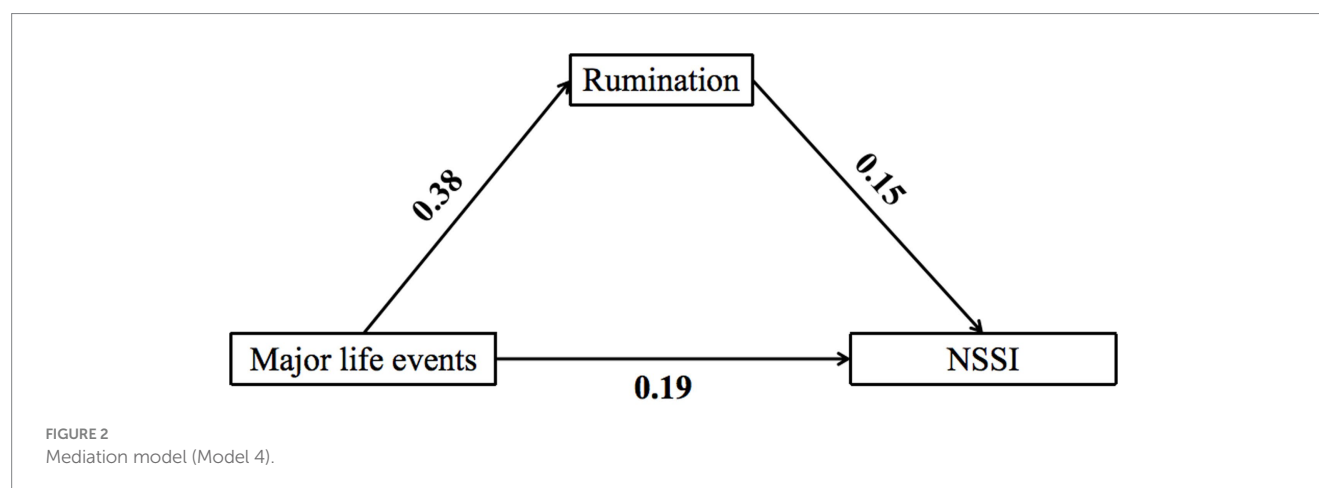
TABLE 3 Total, direct, and indirect effects of major life events on NSSI.

	Effect	Boot SE	95% Boot LLCI	95% Boot ULCI
Direct effect	0.146	0.021	0.105	0.187
Indirect effect	0.072	0.012	0.051	0.096
Total effect	0.218	0.020	0.180	0.256

Meanwhile, the results of the study showed that body image was negatively related to major life events ($r = -0.22$, $p < 0.001$), rumination ($r = -0.29$, $p < 0.001$), and NSSI ($r = -0.18$, $p < 0.001$).

3.5 Mediation effect test

As shown in Figure 2 and Table 3, there was a positive correlation between major life events and NSSI ($\beta = 0.218$, $p < 0.001$). The inclusion of rumination as a mediating variable maintained the significant positive relationship between major life events and NSSI ($\beta = 0.189$, $p < 0.001$). In addition, there was a significant positive correlation between major life and rumination ($\beta = 0.382$, $p < 0.001$), and rumination was also positively related to NSSI ($\beta = 0.146$, $p < 0.001$). The findings indicated that major life events were not only directly related to NSSI but also indirectly related to NSSI through the mediating effect of rumination, which accounted for 33.03% (0.072/0.218) of the mediating effect.

3.6 Moderated mediation effect test

Moderated mediation model tests were conducted using Model 15 of PROCESS 4.0, and the model plot is shown in Figure 3. The

direct effect of major life events on NSSI was significantly moderated by body image ($\beta = 0.034$, 95% Cl: [>0.000, 0.068], $p < 0.05$). In addition, body image moderated the relationship between rumination and NSSI ($\beta = -0.039$, 95% Cl: [−0.076, −0.002], $p < 0.05$).

As shown in Figure 4, a simple slope analysis indicated that when individual's satisfaction of their body image increased (on the basis of adding or subtracting one standard deviation), the correlation between major life events and the NSSI was strengthened ($\beta = 0.125$, $t = 5.335$, $p < 0.001$) vs. ($\beta = 0.185$, $t = 6.387$, $p < 0.001$). Whereas as shown in Figure 5, a simple slope analysis indicated that when individual's level of satisfaction with the body image increased (on the basis of adding or subtracting one standard deviation), the correlation between rumination and NSSI was weakened ($\beta = 0.201$, $t = 8.669$, $p < 0.001$) vs. ($\beta = 0.132$, $t = 3.850$, $p < 0.001$).

4 Discussion

The present study revealed a prevalence rate of 11.56% for non-suicidal self-injury (NSSI) within the college student population. This finding matches closely with the results reported in previous research (6). One possible explanation for the high prevalence rate of NSSI among Chinese college students is that some students may be geographically separated from their families for the first time in
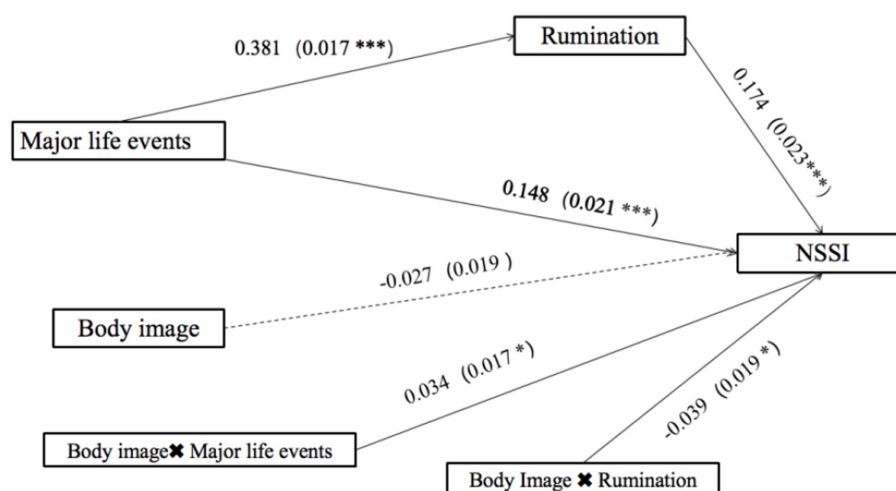
FIGURE 3
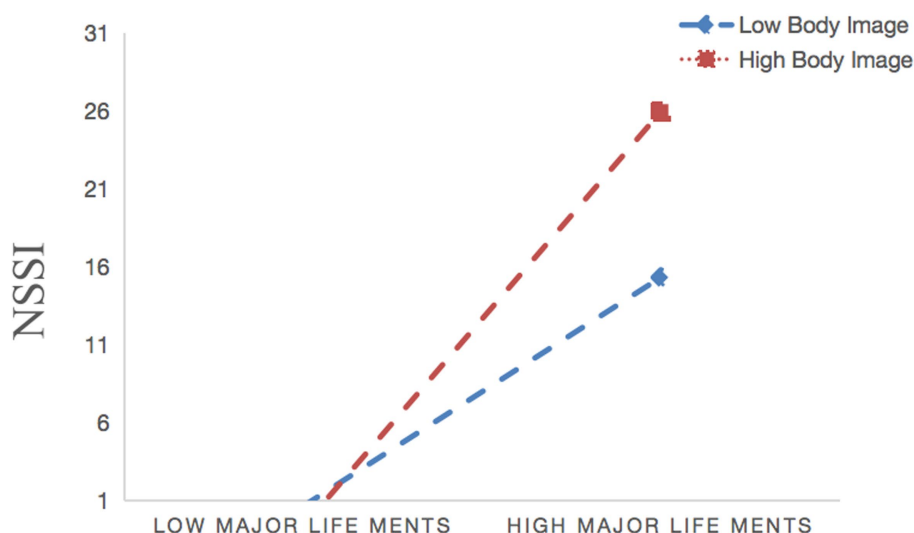Moderated mediation model (Model 15).

FIGURE 4
Interaction effect of body image and major life events on NSSI.

their lives. This transition has the potential to increase their vulnerability to emotional dysregulation and pose challenges in accessing support from both familial and social networks (38, 39). According to Sawyer et al., college students, specifically those aged 18–22 years, can still be categorized as belonging to the adolescent developmental stage (1). Evidence suggests that this group continues to be vulnerable to the incidence of non-suicidal self-injury (1, 40). Hence, additional investigation is warranted to explore the potential risk factors and mechanisms of occurrence associated with this particular association.

The findings of the research additionally provide evidence in support of the hypothesis that major life events and rumination play a significant role in non-suicidal self-injury (Hypothesis 1). According to emotion appraisal theory, emotions arise from people's

interpretations and explanations of the environment in which they find themselves. According to Richard Lazarus, there are two main types of reactions to major life events: automatic, unconscious, and rapidly activated emotional responses, and conscious emotional responses related to how to cope, such as rumination (20). Maladjustment in individuals can occur when they experience negative emotion and engage in negative thinking (41, 42). They tend to release those negative emotions by choosing NSSI, which is relatively easy to obtain and does not require any tools (43). This finding is consistent with Nock's integrative model of NSSI (44). Individuals who are exposed to higher frequency or more severe life events tend to exhibit higher levels of non-suicidal self-injury (NSSI) (45). Additionally, engaging in rumination, which involves persistent negative emotions, makes individuals more vulnerable to becoming
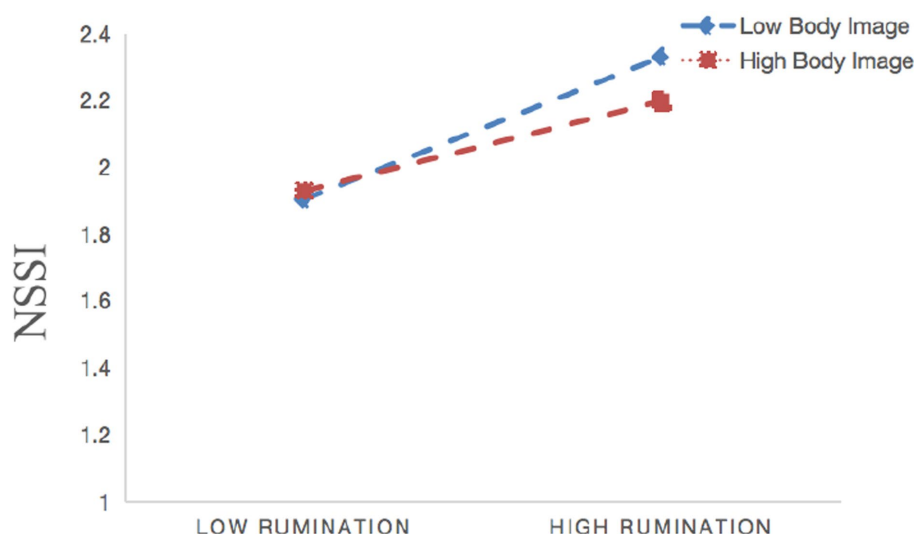
FIGURE 5
Interaction effect of body image and rumination on NSSI.

trapped in negative emotional states (46). Consequently, this susceptibility to prolonged rumination can contribute to the escalation of NSSI behaviors, resulting in greater severity (19, 47).

The present study provides additional evidence for Hypothesis 2, which is derived from the experiential avoidance theory and emotional cascade theory of non-suicidal self-injury (NSSI). Specifically, it posits that persons who experience major life events are more prone to experiencing negative feelings. Which are stacked one on top of the other and constantly reverberate in the individual's mind, making it easy for them to constantly ruminate and get stuck in an emotional rut (24, 48) and thus unable to get out of it, and in order to better dissipate this emotion. Individuals frequently engage in self-harming behaviors as a way of easing their psychological distress, leading to persistent NSSI behavior (49). The findings highlight the significant mediating role of rumination in the relationship between major life events and NSSI. Inter-individual differences are observed within various groups, and certain individuals may engage in NSSI, immediately following a major life event as a way to reduce the negative emotions associated with such event (50). Nevertheless, it is worth noting that certain individuals may not exhibit immediate reactions to major events. Instead, they may engage in a process of contemplation and recollection, often facilitated by rumination. In cases where negative emotions persist and intensify to a certain degree, there is an increased likelihood of the individual developing non-suicidal self-injury behaviors (25, 51).

The results also showed that body image significantly moderated the relationship between rumination and NSSI. Specifically, individuals with a positive body image demonstrated a weaker association between rumination and NSSI compared with those with a negative body image. A stronger relationship is found between rumination and non-suicidal self-injury among those who have poor body image perception. This result is consistent with previous research, implying that body image may serve as a protective factor against NSSI (52). Individuals with high body intention are less likely to engage in NSSI (53). Surprisingly, it is found that body image significantly moderated the relationship between major life events and NSSI. Major life events have a stronger relationship with

NSSI in people who have a positive body image. Conversely, individuals with a negative body image exhibit a weaker relationship between major life events and NSSI. This result could be related to the link between individuals with a positive body image and have a higher self-perception. Individuals who have a strong sense of high self-esteem may experience a greater sense of discrepancy when confronted with a major life event that proves difficult for them to accept (54–56). Consequently, this amplification of emotional difficulties may contribute to an increased likelihood of engaging in non-suicidal self-injury (57).

Drawing from these findings, we suggest that the perception of body image cannot be studied from a single latitude. One potential perspective is that individuals who have a positive body image may be less likely to engage in self-harm behaviors (58). On the contrary, it is important to acknowledge the potential negative consequences of having high levels of body intentions. Individuals with attractive appearances frequently garner admiration and favor from others. However, this can also pose difficulty for them in managing negative emotions and severe major life events. Consequently, visually attractive individuals are more likely to engage in non-suicidal self-injury (53, 59). It is suggested that there may exist a non-linear association between body image, self-esteem, and self-concept with non-suicidal self-injury (NSSI), perhaps manifesting as an inverted "U"-shaped relationship. Additional research is needed. The current research also further provides partial support for Hooley and Franklin's benefits and barriers model of NSSI (26).

While this study enriches our understanding of NSSI to a certain degree and produces intriguing findings, there are some limitations that need to be discussed. First, the current study employed a cross-sectional design. Although it provides some insight into the association among the four variables, it is important to note that it is not possible to establish causal conclusions. Therefore, it is recommended that future studies research endeavors undertake more longitudinal studies. Second, this study employed self-report questionnaires. Although the questionnaires were collected anonymously, the participants may have been affected by the stigmatization of the NSSI and the social expectancy effect. Future studies should use as many evaluation methods as possible. This study

proposes the possibility of a non-linear association between body image and non-suicidal self-injury (NSSI), highlighting the need for additional investigation in this area.

In summary, the current research expands upon existing research by investigating the underlying mechanism linking major life events and NSSI among college students. The current research is the first research in establishing a relationship between major life events and non-suicidal self-injury (NSSI), with rumination identified as a mediating factor between the two and the moderating role of bodily image in different pathways. It is imperative for parents, school workers, and clinicians to not only acknowledge the major life occurrences that college students encounter but also assist them in acquiring additional strategies for emotional regulation and mitigating the occurrence of emotional rumination. Parents, teachers, and healthcare providers should provide more services to help students mitigate negative rumination, such as rumination-based cognitive behavioral therapy (60, 61) and mindfulness therapy (62).

In the context of teenagers experiencing emotional difficulties, enhancing their body image can potentially lead to an increased appreciation of their physical appearance, hence perhaps reducing the occurrence of non-suicidal self-injury (NSSI) behaviors. On the other hand, attention should also be paid to the ability of college students to withstand setbacks. Higher self-evaluation may also produce undesirable results, such as it is more difficult to accept that life has become bad and make people more difficult to withstand major events in life. We hypothesize that there may exist a non-linear association between body image, self-esteem, and self-concept with non-suicidal self-injury (NSSI), perhaps manifesting as an inverted "U"-shaped relationship, but this hypothesis requires further research.

Data availability statement

The datasets generated and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics statement

The studies involving humans were approved by the Ethics Committee of the School of Psychology, South China Normal University. 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

HZ: Conceptualization, Methodology, Project administration, Writing – review & editing. WZ: Conceptualization, Methodology, Project administration, Writing – review & editing. YL: Conceptualization, Methodology, Writing – review & editing. WW: Conceptualization, Methodology, Writing – review & editing. JW: Conceptualization, Methodology, Writing – review & editing. QQ: Conceptualization, Methodology, Writing – original draft. GY: Conceptualization, Methodology, Writing – original draft. CZ: Formal analysis, Writing – review & editing. XK: Formal analysis, Writing – review & editing.

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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.

Publisher's note

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Folie et Société: eroding the body−mind relationship via dysfunctional paternalistic systems

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This theoretical perspective examines the proposition of shared complex trauma between a parent and child, arising from blurred relational boundaries and societal oppression, leading to inequality both at home and within the larger paternalistic system of society. Specifically, the focus is on living within a paternalistic, authoritarian system where rules are unjust, demanding obedience and compliance without questioning the behaviors of the authority. Individuals growing up in these circumstances are subject to adverse and emotionally overwhelming experiences, which lead to the creation of emotional memory images (EMIs). The delusion in which the child is caught up becomes a reality for the child as time passes. This phenomenon is recognized in psychiatry as "Folie à deux" (the madness of two or more) at the micro level, and "Folie et Société" (the madness of society) on the macro level. Complex trauma, derived from a child's exposure to multiple adverse events, can erode the mind−body relationship, impacting both mental and physical health. These traumatic experiences in early childhood can manifest as body-focused disorders in adolescents, prevailing throughout adulthood if left unattended. This article provides a theoretical perspective on dealing with the dissociation and chronic stress related to oppressive and authoritarian family systems. The broader implications of this article include highlighting the psychophysiological underpinnings of complex trauma, the relationship of a highly oppressive paternalistic authoritarian system imposed on children and adolescents, and the role of Split-Second Unlearning as a therapeutic intervention to clear EMIs and improve overall health outcomes.

Introduction

Research spanning decades has established a link as strong as the connection between smoking and lung cancer, demonstrating that child maltreatment significantly affects social, behavioral, mental, and physical health throughout a person's lifetime (Bentall et al., 2014). Psychological or emotional abuse, often a prevalent yet overlooked form of child maltreatment, has only recently gained more attention (Dube et al., 2023). There are firm links between childhood trauma and the sequelae in adult health (Afifi et al., 2016; Herzog and Schmahl,

2018). Adverse childhood experiences (ACEs) (Centers for Disease Control and Prevention, 2021) not only heighten the likelihood of mental health issues but also leave a lasting impact on the body, increasing the risk of physical illnesses and even death (Hughes et al., 2017). Specifically, individuals who have experienced childhood trauma are more prone to developing somatic ailments like musculoskeletal pain, ear, nose, and throat issues, gastrointestinal problems (Kirmayer et al., 2004), fatigue, and dizziness (Ho et al., 2021). These issues often evolve into chronic conditions like fibromyalgia (Pinto et al., 2023), chronic fatigue (Afari et al., 2014), irritable bowel syndrome (Sansone and Sansone, 2015) and psychosis (Croft et al., 2019; Loewy et al., 2019; Karcher et al., 2020). A plethora of growing evidence suggests that experiences of trauma in childhood may contribute to the development of psychosis (Croft et al., 2019; Loewy et al., 2019; Peach et al., 2019; Karcher et al., 2020), which can be defined by abnormalities within the following categories: delusions, hallucinations, disorganized thoughts, disorganized behavior and negative symptoms (Calabrese and Al Khalili, 2023). Indeed, children of parents with major psychoses often exhibit similar cognitive dysfunctions, and childhood maltreatment further elevates the risk of adult psychoses through unclear mechanisms (Berthelot et al., 2015).

This chronic early trauma or complex trauma results from multiple, interpersonal, adverse events during childhood, undermining a typical caregiving relationship (Wamser-Nanney and Vandenberg, 2013; Kliethermes et al., 2014). Individuals raised in a dysfunctional family environment marked by shared delusions, or Folie à deux, may become predisposed to a wide array of emotional, psychological, neurological, behavioral, and physiological disorders (Hudson and Johnson, 2023a). Folie à deux is a delusional disorder that falls under the mental illness category. It has been repositioned from its previous classification in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), to now be a part of the Other Specified Schizophrenia Spectrum and Other Psychotic Disorders category (Bjelan et al., 2022). The DSM-5 lists ten personality disorders, all of which describe afflicted individuals as having a "*rigid and unhealthy pattern of thinking.*" (Chapman et al., 2023) To date, DSM-5 defined disorders have no scientific etiological basis for pathology, diagnosis, or pharmacological treatment, indeed, no biological basis for these conditions is thought to exist (Scull, 2021). This article aims to shed new light on the influence of dysfunctional familial interactions on mental health conditions in the hope of reducing the shadow that is cast upon the lives of individuals who suffer from this often debilitating disorder. From the initial seed of dysfunction and shared delusion various disorders may flourish, including but not limited to anxiety disorders, depression, post-traumatic stress disorder (PTSD), personality disorders or even certain somatic disease states. For instance, those with Borderline Personality Disorder (BPD) display a heightened sensitivity to social cues, avoiding them more frequently and being more conscious of this behavior compared to the general population. If a caregiver fails to perform the vital role of fostering a sense of continuous existence, the infant may struggle to develop a genuine sense of self (Winnicott, 1965). As a result, the infant may construct a false self, shaped by external pressures. This disruption in the sense of continuous existence leads to the formation of a defensive mechanism aimed at managing the profound distress of disintegration and psychological annihilation (Ogden, 2014).

Theories underpinning this article

Theories that are central to this article surrounding complex trauma:

Structural Dissociation (Steele et al., 2005), which explains the division within the self that results from trauma. Attachment Theory (Bowlby, 1979), which describes how early bonds with caregivers can influence an individual's reaction to trauma.

Traumatic Bonding theory (Dutton and Painter, 1993), also plays a role, detailing the strong emotional connections that can form in abusive relationships.

Split-Second Unlearning (SSU) (Hudson and Johnson, 2021), informs us that psychophysiological stress arises from significant emotional events, leading to chronic conditions like anxiety and fibromyalgia. These events generate emotional memory images (EMIs) that are formed and reinforced within moments—split-second learning. Daily triggers can reactivate these EMIs, causing repeated stress responses and chronic psychophysiological dis-ease. Clients learn to dissociate EMIs from stress responses by becoming observant of their nonverbal responses and "unlearning" or emotionally detaching from the memory.

Folie à Deux delusional beginnings

Folie à deux is a concept coined in 1877 by two French physicians, Lasègue and Falret. It is also called Lasegue-Falret syndrome [Lasegue and Falret, 1877, as cited in Saragih et al. (2019)]. The presence of a shared psychotic disorder between two or more people is commonly observed, such as in cases of schizophrenia and delusional disorder (Kovacevic et al., 2022). In these instances, a person (inducer) induces a delusion to others in society or a household. This condition includes the transfer of delusional ideas from one person to another (Srivastava and Borkar, 2010) when the primary affected person transfers their psychosis to those with whom they share a close relationship (Tsarkov, 2020; Kawasaki, 2022).

The role of a dominant, authoritative, and controlling oppressor is assumed by the delusional caregiver. This abuse of the parental relationship creates emotional overwhelm within the infant or child, leading to the creation of emotional memory images (EMIs) (Hudson and Johnson, 2022). Whenever a similar situation occurs, the EMIs activate the original response that the amygdala selected in order to survive. The presence of the EMI can drive the concept of self from the body, creating a dissociative, trance-like state (Saragih et al., 2019). This may appear to be a flight response, yet it is more akin to a freeze mechanism, as the self remains hypervigilant waiting for the proposed threat to clear (see Kozlowska et al., 2015 for more on fear defence cascade).

According to the World Health Organization (2022), three-quarters of children have faced maltreatment from their parents or caregivers. This can disrupt an individual's sense of self, both mentally and physically, hindering the ability to connect with others, and may even affect consciousness so profoundly that one might psychologically detach from the body for survival. This separation from self can lead to body dysmorphic disorder (BDD), whereby individuals become preoccupied with perceived defects in their physical appearance (American Psychiatric Association, 2013). Specifically, theories suggest that emotional abuse might lead to deep-seated self-criticism in BDD, whereas physical or sexual abuse could be linked to shame, centered on one's physical appearance (Veale and Neziroglu, 2010). Such prolonged

inner processes require an intervention to prevent the development of dissociative pathologies and disorders at an early stage among children from these environments (Sar, 2022).

Dysregulation, or a natural, rational response to a nonconscious threat?

The fear defence cascade, first identified in animal studies, shows specific threat responses; flight, fight (hyperarousal), freeze, tonic immobility, and quiescent immobility (hyporarousal). These survival states are highly adaptive and adjust depending on the proximity of the animal and the predator, thus stress is naturally regulated (see Kozlowska et al., 2015 for an in-depth review). The freeze response is of particular interest as it activates when animals sense a predatory threat, or in lab settings when they encounter environments or specific signals linked to past negative experiences (Kalin and Shelton, 1989; Carrive, 2006). Attentive immobility affords the animal the ability to scan the immediate area for the presence of a predator or prey (the visual cortex is wired for movement in mammalians), while remaining perfectly still or frozen (Bracha, 2004).

Unlike animals, the perceived threat from an EMI within the mind's eye presents an illusion to the brain, activating an appropriate heuristic stress response to the original threatening time and space (Hudson and Johnson, 2022). This activation of the mind and body is commonly reported as dysregulated stress (Roberts and Karatsoreos, 2021). Although the induced individual's reaction to the EMI is genuine, when witnessed by an external observer the response may appear dysregulated and delusional. An individual's behavior at this moment in time would clearly demonstrate detachment from the self and a breakdown of mental functioning.

The mind's eye sees the known unknown

In animal studies, the fear defence cascade operates sequentially depending on the proximity of the prey or predator. The animal kingdom needs to see, smell, or hear the threat in order for the automatic responses to engage and subsequently disengage after the threat has passed. However, what if the predator remains? Flight or fight are then associated with an active state of hyperarousal, while the passive hyporarousal state is associated with freeze. The freeze response is also a state of hypervigilance. The authors assert that the distinction between animal and human responses to fear is that humans have created an EMI. Therefore, EMIs are the upstream stressor that initiates context or content-specific psychophysiological responses (see Figure 1). For instance, when a parent or caregiver shouts at a child who is interacting with a spider, saying, "Do not touch the spider!" it creates an emotionally charged memory imprint (EMI) of fear in the child. Before being yelled at, the child was not fearful of the spider. This newly formed EMI leads to a fear-avoidance response toward spiders, which serves to enhance safety and increase the chances of survival in subsequent interactions.

Freud proposed traumatic memory is actively running in the background as a defence (Freud, 1958). From an evolutionary point of view, the brain defends against the EMI. Although the subconscious mind is totally alert and aware of the threat posed by the EMI, the individual is not. Therefore, the body remains still or numb and the eyes either fixate on or avert from the EMI. Eye fixation or aversion are both indicators of a social anxiety disorder (SAD) and fear (Chen et al., 2020). The induced now views life through an EMI that is situated between reality and the perception of reality. All social interactions, therefore, have the propensity for EMI activation, leaving the induced open to both real and imagined threats as they encounter different facial (visual) and tonal (auditory) cues (Noordewier et al., 2020). The authors propose that the EMI filter creates and supports the child's survival in the short term (for review see Machremi et al., 2022). However, one of the medium- to long-term effects of perceiving life through a delusion is body dysmorphic disorder (BDD). Notably, this disorder is associated with a 48% lifetime hospitalization rate and a concerning heightened risk of early mortality. Additionally, 24–28% of individuals with this condition attempt suicide at some stage in their lives (Feusner et al., 2010).

Pathophysiological and behavioral development of body-focused disorders

The constant presence of an EMI for a subject within a dysfunctional family environment can be evidenced by the underutilization of several structural connections within the visual cortex. Body Dysmorphic Disorder (BDD) subjects have shown unusually low information transfer between the primary and secondary visual cortex areas, as well as within the advanced temporal lobe visual processing systems (Leow et al., 2013). Could it be that the psyche is attempting to minimize the visual component of the EMI in order to make life more bearable? The ventral visual stream (VVS) and the amygdala also share a relationship with the prevalence of BDD (Bohon et al., 2012). This is consistent with fMRI data which demonstrated hypoactivity in dorsal visual and parietal networks within BDD subjects observing photographs or faces. The findings of this study, which included anorexia nervosa (AN) subjects, may hold significance for comprehending the differing and common pathophysiological mechanisms that underlie perceptual distortions of appearance (Moody et al., 2021).

The authors suggest that the presence of an EMI prohibits the individual from seeing their true reflection in the mirror. Although outside of the individual's awareness, an EMI is able to provoke feelings of self-loathing and shame as the contents of the EMI will contain the source of their delusion. Therefore, hyperarousal (fight or flight) is present in AN subjects, where the individuals have learned only to trust their own internal voice and imagery, over the distrust of their hypocritical, delusional caregivers. This may explain how AN patients often fail to see that they are painfully thin and fail to respond to their caregivers' requests for them to eat. Hyporarousal is more prevalent in BDD subjects as they are more akin to communicated psychosis, where although the subjects may be separated from the inducers they are nevertheless still held under their influence (Al Saif and Al Khalili, 2023).

First-time learning and dysfunctional parenting

The SSU theory suggests that EMIs act as extracorporeal bookmarks stored inside the mind's eye, yet outside of the physical body. This nonconscious threat is theorized to cause the hypothalamic pituitary
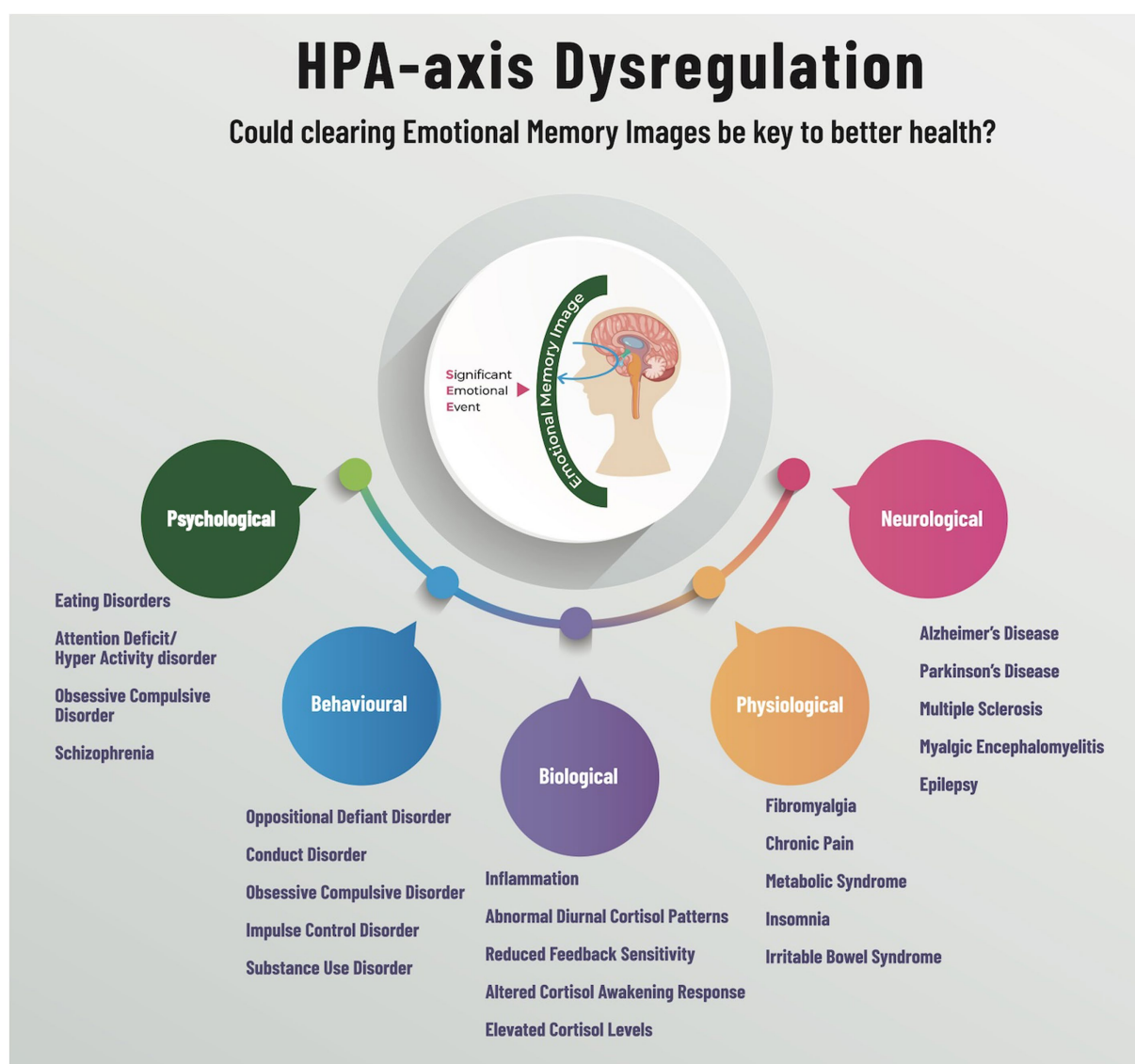
FIGURE 1
The impact of split-second unlearning.

adrenal- axis (HPA-axis) to activate the body's alarm system. When an EMI is initially formed, individuals experience situations that are intensely emotional and beyond their control, which would trigger a freeze response initiated by the HPA-axis. Activities that involve elements of both uncontrollability and social evaluation lead to significant alterations in cortisol and adrenocorticotropin hormone levels, as well as extended periods of recovery (Dickerson and Kemeny, 2004). EMIs have been defined as: "*Trauma induced, non-conscious, contiguously formed, multimodal, mental imagery, which trigger(s) an amnesic, anachronistic, stress response within a split-second.*" (Hudson and Johnson, 2022) The SSU model suggests that the continual activation of this bodily stress response can, over time, lead to various conditions that adversely impact the mind–body relationship, mental health function, and the development of body-focused disorders in adolescence, as well as a myriad of psychophysiological conditions (Hudson and Johnson, 2023b).

Treatment with SSU identifies a non-verbal marker of a subconscious stress response resembling a "freeze" state. In this method, clients actively participate as observers of their own reactions, noting these cues as they occur. By deconstructing the automatic responses, often linked to conditioned reflexes, the client is encouraged to separate their emotional and mental involvement from their physiological stress response, effectively leading to rapid desensitization or "split-second unlearning" (Hudson and Johnson, 2021).

Folie et Société; a delusional paternal system

From an evolutionary standpoint, children depend on parents or caregivers for survival, exhibiting behaviors that foster alliances with those who offer protection and sustenance. Noncompliance with

parental or caregiver directives could significantly jeopardize a child's health and well-being, potentially leading to adverse or even fatal consequences. Therefore, the induced may obey rules that make no logical sense to an outside observer (Hudson and Johnson, 2023b).

On a larger scale, the SARS-Cov2 pandemic saw the widespread utilization of fear and psychological nudges (Almqvist and Andersson, 2021) by governmental "caregivers" to secure public compliance. Governmental authoritarian actions during crises may induce widespread societal distress, extending well beyond family dynamics. In these instances, government and other public agencies may assume a paternalistic, parental role as inducer for broad swathes of the public at large. The targeted utilization of captive media outlets, as well as federal and state officials, could then effectively initiate and maintain fear among the populace to support the aforementioned power imbalance, as well as elements of overall societal dysfunction (Wong et al., 2020; World Health Organization, 2020). Thus, the micro (Folie a Deux) delusion may become macro (Folie et Société). Indeed, the U.K. Minister for Health was quoted as saying that he wanted to "frighten the pants off everyone" during the SARS-Cov2 pandemic, initiating a joint media and government campaign intended to terrify the British public into compliance with hypocritical, dystopian rules (Diver, 2022; Forrest, 2023). The U.K. Prime Minister was also found guilty of misleading the House during the pandemic, where the decisions of many politicians were affected (Jones, 2022; Lilly, 2022).

Lockdowns and quarantines create social isolation and psychological distress for the vast majority who experience them (Brooks et al., 2020; Catty, 2021). In many countries, Folie et Société has continued to affect public opinion and behavior well after the declared end of the pandemic. Indeed, members of the public who disagree with the narrative of the paternalistic system of controls may be viewed by some of the induced populace as suffering from antisocial personality disorder (Black, 2022). However, does it really mean that they are crazy?

Limitations

One of the major limitations of the paper is the unavailability of pilot testing data and results that may demonstrate the usefulness of SSU model in the management of certain psychophysiological conditions. Another limitation may be seen in the development of further guidelines to utilize the SSU model in order to deal with health conditions worsened by chronic traumatic symptoms.

As a theoretical perspective, the paper cannot yet provide these data. Further investigation and study are vital for the identification of EMIs, as well as the determination of efficacy with SSU to treat traumatic sequelae.

Broader implications

- The SSU model's application to biological and somatic systems could aid professionals in developing effective treatments for childhood trauma sequelae and complex PTSD.
- Mitigating the effects of traumatic symptoms could lessen psychopathology risks in adults with histories of family dysfunction and abuse.
- Effective treatment of early childhood trauma could dramatically diminish the demonstrated increased rates of mortality and morbidity from physical health issues.

- Comparing various factors impacting physical health and inflammatory diseases could highlight the need for trauma-informed clinical approaches to managing the litany of physical health conditions pursuant to trauma sequelae.

Future research directions

The new, ICD-10 identifier for PTSD now identifies the diagnosis specifically as an emotional or fear-related disorder, whereas the previous diagnostic criteria of trauma with a variety of symptoms and almost six categories are now regarded as complex trauma. Childhood trauma and its health impacts on adulthood are pervasive across geographical and socioeconomic settings. Therefore, it is recommended that studies to validate the applicability of this intervention should be established.

Conclusion

This article discusses the complex trauma arising from living under paternalistic, authoritarian systems both in family settings and broader society — environments which may be characterized by oppressive rules and blurred boundaries. These settings may foster "Folie à Deux" and "Folie et Société," psychiatric phenomena where delusions are shared between two people or among a society, respectively. That which is classed as a mental health disorder may be considered a natural response to a persistent EMI, or an individual pushing back at the homogenized reality of paternalistic 21st-century societal intrusions. For the former, identifying the presence of an EMI is paramount, while for the latter, validating the incongruence of the paternalistic system is a starting point for improvement and change.

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

MH: Conceptualization, Writing – original draft. NC: Writing – original draft. CN: Writing – review & editing.

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Conflict of interest

MH was employed by Mind Help Limited. MH is the co-founder and co-creator of the MindReset app, which is supported by individual subscribers.

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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Reduced body-image disturbance by body-image interventions is associated with neural-response changes in visual and social processing regions: a preliminary study

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Introduction: Body-image disturbance is a major factor in the development of eating disorders, especially among young women. There are two main components: perceptual disturbance, characterized by a discrepancy between perceived and actual body size, and affective disturbance, characterized by a discrepancy between perceived and ideal body size. Interventions targeting body-image disturbance ask individuals to describe their own body without using negative expressions when either viewing it in a mirror or imagining it. Despite the importance of reducing body-image disturbance, its neural mechanisms remain unclear. Here we investigated the changes in neural responses before and after an intervention. We hypothesized that neural responses correlated with the degree of body-image disturbance would also be related to its reduction, i.e., a reduction in perceptual and affective disturbances would be related to changes in attentional and socio-cognitive processing, respectively.

Methods: Twenty-eight young adult women without known psychiatric disorders underwent a single 40-min intervention. Participants completed tasks before and after the intervention, in which they estimated their perceived and ideal body sizes using distorted silhouette images to measure body-image disturbance. We analyzed the behavioral and neural responses of participants during the tasks.

Results: The intervention did not significantly reduce body-image disturbance. Analysis of individual differences showed distinct changes in neural responses for each type of disturbance. A decrease in perceptual disturbance was associated with bodily visuospatial processing: increased activation in the left superior parietal lobule, bilateral occipital gyri, and right cuneus. Reduced affective disturbance was associated with socio-cognitive processing; decreased activation in the right temporoparietal junction, and increased functional connectivity between the left extrastriate body area and the right precuneus.

Discussion: We identified distinct neural mechanisms (bodily visuospatial and socio-cognitive processing) associated with the reduction in each component of body-image disturbance. Our results imply that different neural mechanisms are related to reduced perceptual disturbance and the expression thereof, whereas similar neural mechanisms are related to the reduction and expression of affective disturbance. Considering the small sample size of this study, our results should be regarded as preliminary.

1 Introduction

Body-image disturbance is characterized by distorted perceptions and attitudes related to one's body, such as a tendency to overestimate one's size, negative self-evaluation of one's body, and an excessive focus on body weight and shape during self-evaluation. It is recognized as a core feature of eating disorders (1, 2). Developing symptoms of an eating disorder is most common among adolescent females; thus, research on the relationship between body-image disturbance and eating disorders has focused mainly on this demographic. Recent studies have revealed that a non-clinical community sample also experience body-image disturbance as strong as those of individuals with eating disorders (3–6). Furthermore, individuals with relatively high body-image disturbance are more likely to develop symptoms associated with eating disorders (7, 8). Several studies have revealed that reduced body-image disturbance is associated with an improved prognosis of individuals with eating disorders (9–12). Therefore, reduction in body-image disturbance is crucial for both the prevention and treatment of eating disorders.

When considering strategies for reducing body-image disturbance, it is crucial to recognize the two components of body-image disturbance, namely perceptual disturbance and affective disturbance, each of which involves distinct psychological and neurological processes. Perceptual disturbance involves distorted perception of one's body size and shape, such as overestimating one's body size (5, 13–15). This component is quantified as the discrepancy between one's perceived and actual body size (perceived–actual discrepancy) (3–6, 15). Previous studies have associated perceptual disturbance in association with attentional bias (4, 16, 17). These studies revealed that individuals with greater perceived–actual discrepancy exhibited specific fixation patterns, such as focusing on the waist. Neurological studies have demonstrated that perceptual disturbance is related to brain activation in bodily visual and attentional processing regions, such as the extrastriate body area, inferior parietal lobule, and anterior cingulate cortex (3, 6, 18–21). Notably, we found that perceived–actual discrepancy was correlated with increased

activation of the left anterior cingulate cortex and functional connectivity between the left extrastriate body area and the right anterior insula when participants were estimating their own body size (6), implying that perceptual disturbance was related to attentional processing rather than visual processing only (22, 23).

On the other hand, affective disturbance involves disturbances in attitudes and feelings toward one's body, such as excessive dissatisfaction therewith (13). Affective disturbance, observed in almost all eating disorders, is related to the excessive influence of weight and shape on self-esteem, a core psychopathological symptom (2, 9). This component is quantified as the discrepancy between one's perceived and ideal body size (perceived–ideal discrepancy) (3–6, 15). Previous studies found that affective disturbance was associated with body-image concerns (5, 15, 24, 25). These studies revealed that the degree of affective disturbance was correlated with eating disorder inventory scores related to body-image concerns, such as body dissatisfaction. Neurological studies have demonstrated that affective disturbance is related to brain activation in emotional and socio-cognitive processing regions, such as the insula, amygdala, precuneus, and temporoparietal junction (3, 6, 20, 26–29). In particular, we revealed that perceived–ideal discrepancy correlated with an increase in activation of the right temporoparietal junction and decrease in functional connectivity between the left extrastriate body area and the right precuneus when participants were estimating their ideal body size (6). Considering that these regions are related to socio-cognitive processing, such as thinking about others (30, 31), these neural responses potentially reflect the influence of social pressure on the establishment of one's ideal body. These psychological and neurological differences between the two types of disturbance imply that distinct neural mechanisms are also involved in reducing each type of body-image disturbance.

However, the neural mechanisms underlying the reduction in each type of body-image disturbance remain unclear. Considering the various psychological processes related to the development and maintenance of eating disorders and body-image concerns, neural responses may differ between the expression and reduction of body-image disturbance (9, 32, 33). Although it is crucial to understand

the neural mechanisms related to the reduction in body-image disturbance, no previous study has directly investigated neural responses related to the reduction in each type of body-image disturbance. Previous studies have focused mainly on individuals with eating disorders and examined changes in neural responses when looking at body images before and after treatment (34, 35). These studies revealed increased activation in the extrastriate body area after treatment, which should be related to a reduction in body-image disturbance. However, these studies did not differentiate between the two components of body-image disturbance, and more importantly, they did not evaluate changes in body-image disturbance before and after treatment. Additionally, the findings from these studies are inconsistent with our previous finding that neural responses were correlated with the degree of each type of body-image disturbance (6). Therefore, it is plausible that the reported neural changes were not directly related to reduced disturbance. Moreover, the identified neural mechanisms can facilitate the development of effective novel treatments. Similar to other psychiatric disorders, interventions targeting neural responses may be effective (36–38). Several non-invasive strategies can be used to manipulate neural responses, such as neurofeedback (39) and transcranial magnetic stimulation (40). In real-time neurofeedback, individuals monitor and attempt to control their neural responses. On the other hand, in repetitive transcranial magnetic stimulation, a specific brain region related to psychopathological symptoms is activated or deactivated using a repeated magnetic pulse. When applied for reduction of body-image disturbance, these approaches target the underlying neural responses, providing novel and effective prevention and treatment strategies for eating disorders. To reveal the neural mechanisms related to the reduction in each type of disturbance, it is necessary to examine brain activation before and after interventions designed to reduce each type of body-image disturbance and investigate neural responses associated with a decrease in each disturbance type.

Two interventions, mirror exposure and mental imagery, have shown promise in reducing types of body-image disturbance, including body dissatisfaction, which is associated with affective disturbance (41–43). These interventions can also decrease attentional bias by diverting attention from specific body parts, implying that they can also reduce perceptual disturbances (4, 43–45). Both interventions encourage individuals to avoid negative expressions about their bodies, such as "fat". Although mirror-exposure interventions have several variations, participants are typically instructed to look at a specific body part in a mirror, ensuring that they view each body part equally, and to describe them without using negative expressions (41, 42, 46–48). Compared to mirror exposure, mental imagery has fewer variations and involves describing one's imagined body instead of looking at it. All studies of mental imagery require the participants to imagine a specific body part according to experimenter's instructions and then describe it (42, 43). Compared to mirror exposure, mental imagery acts indirectly and is associated with a lower risk of aggravating negative feelings on exposure to one's own body image (20, 43, 49). Redistribution of attention is considered a core feature of these

interventions, which can address attentional bias toward specific body parts and reduce perceptual disturbance (4, 43–45). Additionally, several studies have demonstrated that prolonged viewing of unattractive body parts is associated with an increased likelihood of developing body dissatisfaction (5, 43, 50, 51). Mirror exposure and mental imagery share several common procedures that can potentially reduce each component of body-image disturbance. However, the effects of these interventions on both types of body-image disturbance can differ. Previous studies have demonstrated that both mirror exposure and mental imagery can reduce body dissatisfaction, but only mirror exposure was effective in reducing the frequency of negative thoughts and feelings of ugliness (42, 43). Considering the discrepancies between the aforementioned studies and others that demonstrated increased negative feelings on exposure to body image (20, 43, 49), the differences in the effects of the two interventions on each type of body-image disturbance, and the neural mechanisms underlying these effects, remain unclear.

The main objective of this study was to reveal the neural mechanisms underlying reductions in perceptual and affective disturbances. To achieve this, we recruited young women with body-image disturbance who had not been diagnosed with any psychiatric disorders, including eating disorders. We evaluated perceived–actual and perceived–ideal discrepancies before and after interventions, as well as functional magnetic resonance imaging (fMRI) data. We conducted multiple regression analysis to investigate the relationship between changes in neural responses and the reduction in each type of discrepancy. Based on our previous study (6), we hypothesized that neural responses related to the degree of each type of body-image disturbance would also be related to the reduction thereof. In other words, we expected that changes in attentional processing would be related to reduced perceptual disturbance, whereas changes in socio-cognitive processing would be related to reduced affective disturbance. A decrease in the perceived–actual discrepancy was expected to be associated with deactivation of the left anterior cingulate cortex and a reduction in functional connectivity between the left extrastriate body area and the left anterior insula. Similarly, a decrease in the perceived–ideal discrepancy was expected to be associated with deactivation of the right temporoparietal junction and an increase in functional connectivity between the left extrastriate body area and the right precuneus. Because the different procedures (i.e., looking at one's body or imagining specific body parts) involved in the interventions can have distinct effects on body-image disturbance, we also investigated potential differences in neural responses related to the reduction in body-image disturbance associated with each intervention. Participants were randomly assigned to the mirror-exposure or mental-imagery group. There were no significant differences between the two groups in terms of behavioral factors (see Results for details). Therefore, this study evaluated group differences in neural mechanisms by examining two-factor interactions between intervention groups and neural-response changes related to body-image disturbance, rather than directly comparing neural-response changes between the two intervention groups.

2 Materials and methods

2.1 Ethical statement

The study protocol was approved (2020-1-1049) by the Ethics Committee of Tohoku University Graduate School of Medicine, Japan. Informed consent was obtained from all participants, and the study was conducted in accordance with the Declaration of Helsinki.

2.2 Study design

This fMRI study investigated the changes in neural responses related to the reduction in body-image disturbance before and after body-image interventions. Participants performed two tasks related to body-image disturbance in an MRI scanner before and after body-image interventions; the changes in the degree of body-image disturbance and neural responses were evaluated. We conducted a brief (1-day) intervention without any follow-up to determine acute changes in behavioral and neural responses. We examined the reduction in body-image disturbance at the collective and individual levels, assessing neural responses related to the reduction in each type of body-image disturbance. This study was conducted between November 2021 and June 2022 in Sendai, Japan.

We recruited women aged 20–35 years to examine body-image disturbance by community-based sampling because non-clinical individuals can have similar body-image disturbance to patients (3, 4). To reveal neural mechanisms related only to the reduction in body-image disturbance, recruiting non-clinical individuals has advantages. Several studies have investigated brain structures and neural responses while participants doing nothing, and they suggested that people with eating disorders showed neurological differences compared with non-clinical individuals (52–55). These neurological changes are not directly derived from body-image stimuli; thus, it could be related to other factors, such as psychiatric characteristics like depression, anxiety, and so on. In addition, people with anorexia nervosa have serious nutritional problems (2), which also influences brain structure and neural responses (56). Furthermore, understanding the neural mechanisms associated with the reduction in body-image disturbance in non-clinical individuals can facilitate the development of prevention methods, which are particularly important because eating disorders are often refractory to treatment (57, 58). Finally, fMRI studies of non-clinical individuals can define regions of interest (ROIs), which could provide useful information for future neuroimaging studies involving patients. Considering the challenges in recruiting patients with eating disorders, achieving significant results through exploratory voxel-wise analysis is difficult. Therefore, the accumulation of findings from non-clinical individuals is essential for advancing clinical research.

To minimize the recruitment time, individuals older than the legal adult age (i.e., 20 years) in Japan were recruited to this study. The age range of the study participants was similar to that reported in previous studies (46, 47, 49). A previous study investigating body-image-disturbance in women aged 17–40 years found no

significant decline with age (59). Therefore, the recruitment of women aged 20–35 years was deemed suitable for including late adolescents. Additionally, the recruitment only of women was appropriate considering the study design, which involved manipulating body width and assumed that the ideal body concept of participants was that a slimmer body is "better". Despite the diversity in contemporary women's ideal bodies, including lean, curvy, and toned bodies (60), women's ideal body image is still less influenced by muscle mass compared to men's ideal body image (61–64). In particular, Japanese women continue to have slimmer ideal bodies (65).

To examine the degree of body-image disturbance (i.e., perceived–actual and perceived–ideal discrepancies), we used silhouette images distorted in width obtained from each participant's photograph. Participants estimated their actual and ideal body sizes by examining these distorted silhouettes. Despite the availability of standardized three-dimensional (3D) body images for Japanese women (66), the body mass index (BMI) range of these nine body images did not align with the participants' BMI. Additionally, previous studies have demonstrated the superiority of using one's own body instead of standardized images to evaluate body-image disturbance (67–69). Previous fMRI studies investigating body-image disturbance have demonstrated differential neural responses when participants view their own bodies compared to others' bodies (26, 70). Some behavioral studies have manipulated 3D images of participants' own bodies (71, 72) or body parts (73) based on changes in actual body shape to increase the realism of stimuli. However, such techniques have been based on body-size databases of White individuals and are applicable only to White participants. Considering a previous study indicating that silhouette images can effectively represent individuals with different body sizes (74), we used participants' own silhouette images, in line with our previous studies (6, 15). Neural responses during estimation were recorded. Behavioral and neurological data were obtained before and after the interventions.

Participants underwent a brief (1-day) mirror exposure or mental imagery intervention, each lasting 40 min. Brief interventions can effectively reduce scores on questionnaire related to body-image concerns (46, 47). Considering the burden on participants and previous studies, 1-day interventions were implemented in this study. The interventions lasted for 40 min because a previous study showed that at least a 30-min exposure to bodies is needed to reduce body-image concerns.

We conducted multiple regression analysis to investigate neural responses related to the reduction in body-image disturbance. Neural response changes before and after interventions were predicted by changes in perceived–actual or perceived–ideal discrepancy, with controlling for body-image concerns before interventions. In addition to the main analysis, we compared behavioral and neural changes before and after the interventions.

2.3 Participants

The study included right-handed women aged 20–35 years with no history of psychiatric disorders or current involvement in weight loss plans. In total, 32 non-clinical women were recruited from the

undergraduate or graduate school of Tohoku University (n = 28) or the nearby general population (n = 4). Participants were recruited using advertisements displayed in the university office and a local newspaper. Using the conventional method, we determined the sample size based on similar fMRI studies. Only two previous fMRI studies have compared neural responses before and after interventions targeting body-image disturbance (34, 35); one of them recruited 5 participants (34), and the other recruited 32 people with eating disorders (17 were assigned to a therapy group and 15 to a control group) (35). Thus, we recruited 32 people and assigned them to the mirror-exposure and mental-imagery groups by block randomization, with the block size determined randomly (two, four, or six) (75) and 16 participants assigned to each group.

2.3.1 Pre-screening

The 32 participants underwent a pre-screening test to confirm the presence of body-image disturbance, involving an assessment of perceived–actual and perceived–ideal discrepancies using 3D body images of Japanese women (66). We recruited people with high body dissatisfaction, as the level of body dissatisfaction before the mirror-exposure intervention can influence its effectiveness (46). The perceived–ideal discrepancy was examined because it is correlated with body dissatisfaction (5, 15, 24). Moreover, the perceived–ideal discrepancy was targeted for reduction by the interventions, and this pre-screening process ensured recruitment of individuals with more severe affective disturbance (i.e., those who perceived themselves as overweight compared to their ideal body image). During the pre-screening process, individuals assessed their actual and ideal body sizes based on nine body images with BMI values ranging from 16.5 to 24.5 kg/m^2. Then, we calculated the "BMI-based actual–ideal discrepancy". Individuals with perceived–ideal discrepancy ≥ 2 BMI points (i.e., they perceived themselves to be overweight relative to their ideal body by 2 BMI points) were recruited. This criterion was determined based on a previous study, which found that the mean BMI-based actual–ideal discrepancy in Japanese adolescent women was about 2 BMI points (25).

2.3.2 Exclusion criteria

We excluded males as well as individuals who were left-handed, aged < 20 or > 35 years, pregnant, or following weight-loss plans. Individuals with a history of psychiatric disorders, claustrophobia, or metal implants were also excluded from the study. The history of psychiatric disorders was self-reported rather than physician-assessed.

Participants with excessive body movement or an insufficient number of valid scans were excluded (see section 2.7.2 for details). Finally, we analyzed data from 28 participants (14 in each group). A two-sample t-test revealed that there were no significant differences between the groups before the intervention, except for scores on a questionnaire related to body-image concerns (Table 1). $P < 0.05$ was considered statistically significant.

2.4 Experiment outline

Participants visited our laboratory on 2 days. On day 1, we acquired whole-body photographs of the participants, which were converted into silhouette images. On day 2, the participants completed a psychological experiment in an MRI scanner before and after the intervention (Figure 1).

2.5 fMRI tasks

2.5.1 Stimuli

To assess each participant's perceived and ideal body images, we created silhouette images for each participant along with a black square of equal area. The silhouette images were altered in width to represent various body sizes, and the black squares served as a control. This methodology is similar to that used in our previous studies (6, 15). In brief, we obtained photographs of each participant and then converted them into a silhouette image. Both the silhouette images and the black squares were modified in terms

TABLE 1 Demographic data of participants and changes in behavioral indices before and after the interventions.

	Mean (SD)				p-value		
	Mirror exposure		Mental imagery		All participants	Group comparison	
	Pre	Post	Pre	Post	Pre vs. Post	Pre	Pre vs. Post
Age	22.1 (1.64)	–	22.8 (2.69)	–	–	0.40	–
BMI (kg/m^2)	20.9 (3.23)	–	21.5 (2.42)	–	–	0.62	–
Perceived–actual discrepancy (%)	7.33 (4.90)	7.91 (7.61)	6.73 (5.44)	8.88 (5.28)	0.34	0.76	0.65
Perceived–ideal discrepancy (%)	7.99 (7.86)	9.79 (11.6)	8.91 (8.82)	11.5 (10.8)	0.49	0.77	0.89
EDI2	51.4 (13.9)	51.7 (13.2)	64.0 (15.0)	62.1 (14.6)	0.30	0.03*	0.38

The mean age, body mass index (BMI), degree of body-image disturbance, and Eating Disorder Inventory 2 (EDI2) scores of the 28 participants are presented. The degree of body-image disturbance and EDI2 scores were examined before ("Pre" columns) and after ("Post" columns) the interventions. Numbers in parentheses are standard deviation. A two-sample t-test was conducted to examine pre-intervention group differences, and the results are presented as p-values ("Pre" column in the "Group comparison" column). Multiple regression analysis was performed to examine the effects of interventions. The "Pre vs. Post" columns show the p-values of multiple regression analysis to examine the effects of intervention on each discrepancy. The significance of the partial regression coefficient for the main effect of intervention (i.e., data pooled from both groups) is shown in the "All participants" column. The significance of the partial regression coefficient for the interaction term, the interaction between groups (mirror exposure vs. mental imagery) and interventions (pre-intervention vs. post-intervention), is shown in the "Group comparison" column. The threshold for statistical significance was set at $p < 0.05$.
*$p < 0.05$.
-: Not Applicable.
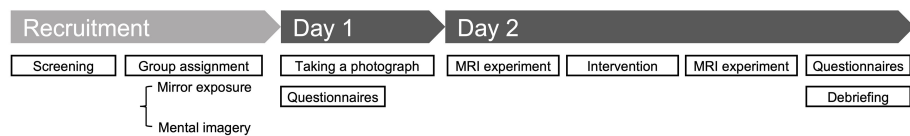
FIGURE 1
Study outline. Participants presented to the laboratory on 2 days. On Day 1, they were photographed and completed the questionnaires. On Day 2, they completed psychological tasks in an MRI scanner to record their neural responses before and after the interventions. Following completion of the tasks, they filled out the questionnaires again and received a debriefing on the same day. Figure 2 presents the details of the psychological tasks.

of width, consistent with previous studies (3, 15, 74, 76, 77). In total, 21 images were created by varying the width between −25% and +25% of the original width. We altered the width of the original image in increments of 2% from −15% to −1% and from +1% to +15%, resulting in 16 images. Additionally, we altered the original width image in increments of 5% from −25% to −20% and from +20% to +25%, resulting in four images. Therefore, we created a set of 21 images, including the original image (see 6, 15 for further details).

2.5.2 Task design

During the fMRI task, participants viewed a silhouette image or a black rectangle and then made judgements regarding the width of the image (Figure 2). The fMRI task design was similar to that used in our previous study (6), except for the block design and number of trials. Participants completed actual-body, ideal-body, and control

tasks in an MRI scanner. Before the task, each participant received a detailed explanation that the stimuli would be distorted in terms of width, and they were required to consider only the width of each image. In the actual-body task, participants judged whether the presented body image was wider than their actual body image, whereas in the ideal-body task, they assessed whether the presented body image was wider than their ideal body image. In the control task, they judged whether the presented black rectangle was wider than a square. This control task was used to isolate brain activity specific to body-image processing. Participants were instructed to make up their mind regarding their answers while viewing the silhouettes or rectangles. Participants practiced the tasks outside the MRI scanner, and they completed 12 trials for each task.

Participants viewed the silhouette image for 3 s and were required to press a button within 1 s. The intervals between trials were set at 2, 4, or 6 s, with a fixation image presented during each
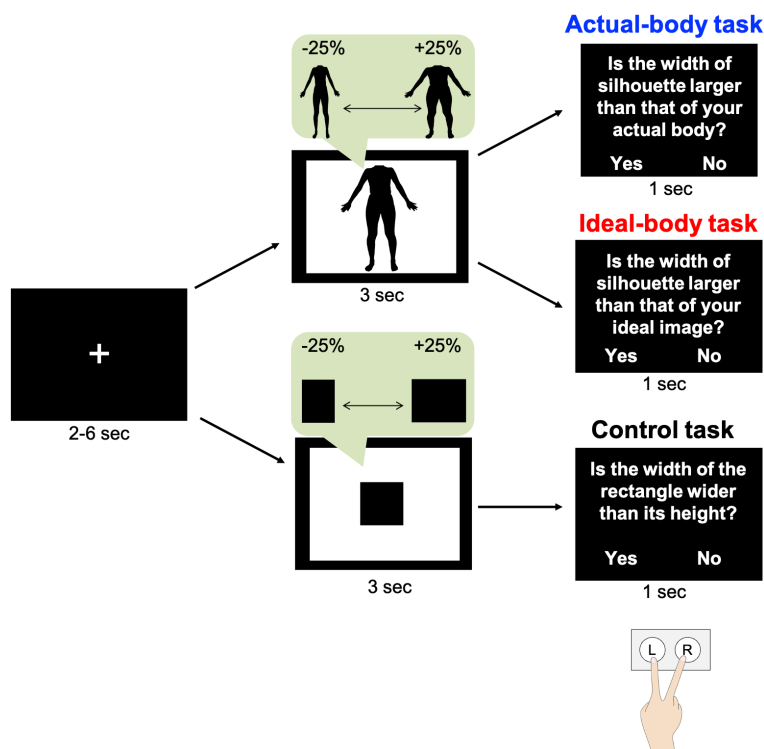
FIGURE 2
Experiment outline. In each trial, following visual fixation for 2, 4, or 6 s, participants viewed their distorted silhouette image or a black rectangle for 3 s. Subsequently, they responded to questions by pressing the appropriate key. These tasks were similar to those in our previous study (6). The figure has been adapted from the previous study.

interval. Participants viewed their silhouette body image or a black rectangle (21 images with widths from −25% to +25%) twice in random order, resulting in 42 trials for each task. The stimulus presentation was based on a mixed design. Each task was conducted in a separate fMRI session, and participants completed the fMRI tasks in two phases; pre- and post-intervention. Thus, there were three sessions in each phase for a total of six sessions. The order of tasks was counterbalanced across participants. Participants provided their responses by pressing buttons on a keypad held in their right hand, with their index and middle fingers positioned over two buttons representing "yes" and "no." The correspondence between fingers and responses was counterbalanced across participants. The participants viewed each task through a mirror mounted on the head coil. All tasks were controlled using PsychoPy 2021.1.4 (78).

2.6 Intervention tasks

An overview of the interventions is provided in Figure 3. In both interventions, participants were instructed to describe their body parts without using negative, critical, or subjective expressions after looking at the body part in a mirror (mirror-exposure group) or imagining it (mental-imagery group). In the mirror-exposure group, participants changed into the clothing that they had worn to create the silhouette stimuli and stood in front of a three-way mirror. First, they viewed their bodies freely in the mirror for 3 min to become accustomed to the situation. Next, they focused on a specific body part for 10 s and provided two descriptions of the body part within 25 s, following the experimenter's instructions (46, 47). The order of body-part description was hair, skin, eyes, nose, mouth, neck, arms, chest, abdomen, waist, buttocks, hips, thighs, calf, and feet (47), with intervals of 25 s between each description. Participants were instructed to imagine that they were providing descriptions for a self-portrait by a blind artist and were instructed to avoid using negative, critical, or subjective expressions when describing their bodies (41). Expressions such as "big," "fat," "like," and "beautiful" were discouraged, and participants were instead encouraged to use descriptions related to color, texture, and

proportion. On the other hand, in the mental-imagery group, participants only imagined their body parts, without looking in a mirror, and were given similar instructions to those in the mirror-exposure group, except the instructions to change clothes and look in the mirror (42, 43). Both interventions were conducted by the first author in the same room and took approximately 40 min.

2.7 Behavioral data analysis

To investigate the effects of the two interventions on each component of body-image disturbance, we examined the degree of body-image disturbance (see section 2.6.1 for details) and questionnaire scores (see section 2.6.2 for details) before and after each intervention. Statistical analysis was performed to investigate changes in these behavioral indices (see section 2.6.3 for details).

2.7.1 Degree of body-image disturbance

We determined the perceived–actual and perceived–ideal discrepancies by examining the silhouette sizes of each participant's perceived-self and ideal images, following the methodology used in previous studies (6, 15). The sizes of the perceived and ideal body images were determined based on participants' selections in the actual and ideal-body tasks, respectively (Figure 4). Logistic regression was used to model participants' selection behavior as $P_{yes} = 1/[\exp(-\alpha X - \beta) + 1]$, where P_{yes} represents the probability of a "yes" response, X indicates the degree of silhouette distortion, and the free parameters α and β control the slope shape. Notably, the distortion level X at which the participants changed their choice from "yes" to "no" corresponds to the size of the perceived or ideal body, denoted as X_{perc} and X_{ideal}, respectively.

2.7.1.1 Degree of perceptual disturbance

Perceptual disturbance was defined as the discrepancy between perceived-self body size (X_{perc} in Figure 4A) and actual body size ($X = 0$ in Figure 4A). Thus, the perceived–actual discrepancy was determined as the absolute value of X_{perc} – zero (blue arrow in Figure 4A). For the perceived–actual discrepancy, we followed
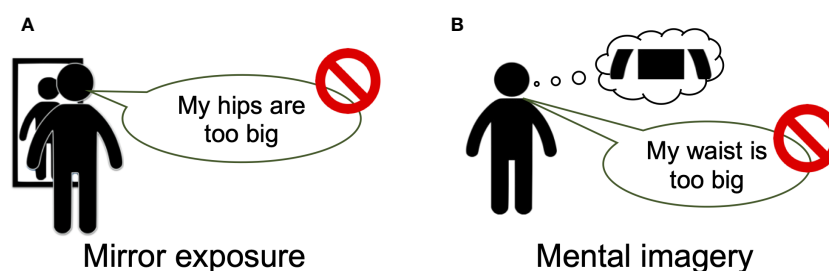
FIGURE 3
Overview of the interventions. Overview of the mirror-exposure **(A)** and mental-imagery **(B)** interventions. In both interventions, the participants described their body parts without using negative or subjective expressions. Prior to this description, **(A)** participants in the mirror-exposure group were instructed to view the body part, **(B)** whereas those in the mental-imagery group were instructed to imagine the body part. Participants viewed or imagined specific body parts for 10 s, provided two descriptions of each body part in a 25-s period, and then rested for 25 s. This 1-min cycle was repeated for 15 body parts.
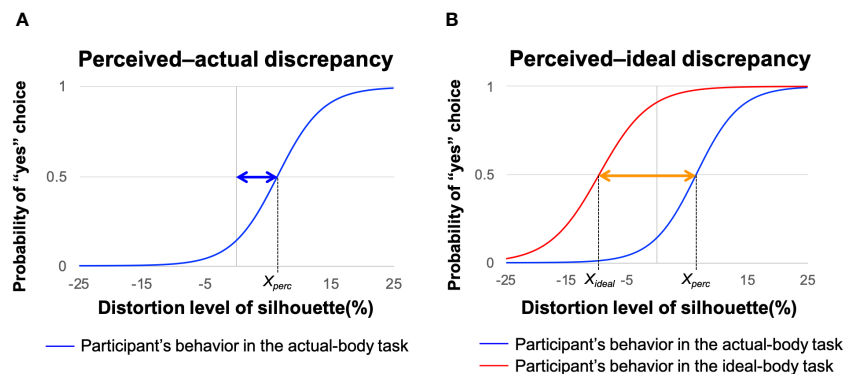
FIGURE 4
Procedures for estimating perceived–actual and perceived–ideal discrepancies. Representative behavior of a participant during the actual-body (blue line) and ideal-body (red line) tasks based on logistic regression modeling. **(A)** Blue arrow represents the perceived–actual discrepancy, defined as the probability of selecting "yes" on the actual-body task of 0.5 (X_{perc}). **(B)** Orange arrow represents the perceived–ideal discrepancy, defined as the discrepancy between the probability of selecting "yes" on the actual-body task of 0.5 (X_{perc}) and the probability of selecting "yes" on the ideal-body task of 0.5 (X_{ideal}). Adapted from Hamamoto et al. (6).

recent conventions and converted X_{perc} – zero (blue arrow in Figure 4A) to an absolute value (79–81). Although we did not use this convention in our previous studies (6, 15), a reanalysis using absolute values confirmed our previous findings. A greater perceived–actual discrepancy indicated that the participant estimated her body size less accurately, regardless of the direction of misestimation.

2.7.1.2 Degree of affective disturbance

Affective disturbance was defined as the discrepancy between perceived-self body size (X_{perc} in Figure 4A) and ideal body size (X_{ideal} in Figure 4B). Thus, the perceived–ideal discrepancy was obtained by subtracting the participant's ideal body estimate from her perceived body estimate ($X_{perc} - X_{ideal}$; orange arrow in Figure 4B, adapted from 6). A positive perceived–ideal discrepancy value indicated that the participant evaluated her body size as larger than her ideal body.

2.7.2 Questionnaire

To examine participants' body-image concerns, we used the body-dissatisfaction and drive-for-thinness subscales from the Japanese version of the Eating Disorder Inventory 2 (EDI2) questionnaire (82), which is the most recent Japanese translation. These two subscales are associated with body-image disturbance (83, 84), and scores thereon were obtained before and after the interventions. There were nine and seven items for body dissatisfaction and drive for thinness, respectively. The EDI2 score is typically transformed (e.g., if participants rated an item as 1–3, the score was converted to 0, while score of 4–6 were transformed to 1–3) when evaluating symptom severity in clinical populations. However, we adopted a raw-score rating approach, where we recorded a score of "1" if participants rated an item as "1," based on a previous study that suggested that this approach is suitable for non-clinical sample (85). We summed the ratings of the 16 questionnaire items. For reference purposes, transformed scores were described in Supplementary Table 1. Only one participant

showed above a cut-off score for drive for thinness, it has been set at 14< (86, 87). There is no widely used cut-off score for body dissatisfaction in EDI2.

2.7.3 Behavioral changes before and after the interventions

To investigate the effects of mirror exposure and mental imagery, we examined changes in perceived–actual and perceived–ideal discrepancies. Furthermore, we explored the effects of the interventions on eating-disorder characteristics related to body-image disturbance. These behavioral indices were assessed before and after the interventions. Due to significant group differences in the questionnaire scores related to eating-disorder characteristics before the intervention (Table 1), we performed analysis of covariance instead of two-way analysis of variance to examine the effect of each intervention while controlling for the pre-existing group difference. The independent variables in the analysis were the main effect of group (mirror exposure = 1, mental imagery = 0), the main effect of intervention (pre-intervention = 0, post-intervention = 1), the interaction between group and intervention, and the confounding factor of questionnaire scores. We evaluated the significance of the main effect of intervention and the interaction term. $P < 0.05$ was considered indicative of statistical significance. The behavioral data were analyzed using R software (version 4.2.1; R Core Team, Vienna, Austria).

2.8 fMRI data acquisition and preprocessing

2.8.1 Data acquisition

All images were acquired using a Philips Achieva 3T MRI scanner (Philips, Best, The Netherlands). The whole-brain fMRI dataset was obtained using T2*-weighted gradient echo-planar imaging and comprised 40 gradient-echo images (echo time = 30 ms, flip angle = 85°, slice thickness = 2.5 mm, slice gap = 0.5 mm,

field of view = 192 mm, matrix size = 64 × 64). These images covered the entire brain and were obtained using a repetition time of 2,500 ms. In addition, structural whole-brain images were acquired using magnetization-prepared rapid-acquisition gradient-echo, employing the following imaging parameters: repetition time = 6.7 ms; echo time = 3.1 ms; field of view = 192 mm, number of slices = 162, and slice thickness = 1 mm. These parameters were similar to those used in our previous study.

2.8.2 Preprocessing and outlier exclusion

We conducted preprocessing procedures using statistical parametric mapping software (SPM12; Wellcome Center for Human Neuroimaging, London, UK), the CONN functional connectivity toolbox (version 21a; www.nitrc.org/projects/conn, RRID: SCR_009550) (88), and MATLAB software (MathWorks Inc., Natick, MA, USA). We used a preprocessing pipeline implemented in CONN, which included correction for head motion, adjustment of acquisition time across slices, co-registration to anatomical images, spatial normalization using anatomical images and the Montreal Neurological Institute template, and smoothing using a Gaussian kernel with a full width at half maximum of 6 mm.

Participants with outlier values for body movements and the number of valid scans (< [first quartile – 1.5 × interquartile range] or > [third quartile + 1.5 × interquartile range]) were excluded. Two participants were excluded because of excessive body movements (> 4.4 mm), and two were excluded due to an insufficient number of valid scans (< 775 scans).

2.9 fMRI data analysis

To investigate the neural-response changes related to reductions in each type of body-image disturbance, we examined the correlation between these changes (i.e., regional neural activity and cross-regional functional connectivity) and the decrease in each type of body-image disturbance (i.e., perceived–actual and perceived–ideal discrepancies). We examined the neural-response changes correlated with reductions in each type of discrepancy at the whole-brain level (see sections 2.8.1.1 and 2.8.1.2 for details). Additionally, we explored neural-response changes in brain regions that we had previously identified as being related to each type of body-image disturbance (6), with a less stringent significance threshold (see sections 2.8.2.1 and 2.8.2.2 for details). We also checked for the same neural responses observed in our previous study before the interventions (see section 2.8.2.3 for details).

2.9.1 Voxel-wise whole-brain analyses
2.9.1.1 Changes in regional neural activity

Data were analyzed within SPM12 (89) using a conventional two-level approach, similar to our previous study (6).

In the first-level analysis of regional neural activity, we aimed to isolate neural responses related to the body width of the presented stimulus for each task. We modelled the event at the onset of the presentation of the silhouette or rectangular image with a duration

of 3 s. This conventional canonical neural response was accompanied by a model that parametrically represented modulated neural responses based on the silhouette width in each trial relative to the canonical neural response, consistent with our previous approach (6). Consequently, there were two regressors representing neural responses in each task and the size of the presented stimuli in each phase. The task consisted of three levels: actual body, ideal body, and control. The phase consisted of two levels: pre- and post-intervention. Trials in each task were categorized based on the width of the presented stimulus, because previous studies have suggested that width-dependent neural responses are related to body-image disturbance (6, 90–92). We used two stimulus sizes, as determined previously (6): trials where participants were presented with larger body silhouettes (body width from 0 to +25) and those where they were presented with smaller body silhouettes (body width from −1 to −25). In total, 24 regressors representing neural responses were modelled: two neural-response models × three tasks × two phases × two stimulus sizes. Additionally, we incorporated the six estimated head-movement parameters obtained via preprocessing as regressors (covariates of no interest) to account for the effect of head motion. We applied a high-pass filter with a cut-off of 128 s.

In the second-level analysis of changes in regional neural activity, we performed a multiple regression analysis using contrast images created by subtracting pre-intervention images from post-intervention images i.e., post-intervention (actual-body task – control task) – pre-intervention (actual-body task – control task) and post-intervention (ideal-body task – control task) – pre-intervention (ideal-body task – control task). The contrast related to the actual-body task was used to analyze the reduction in perceived–actual discrepancy, whereas the contrast related to the ideal-body task was used to analyze the reduction in perceived–ideal discrepancy. We assessed the correlations between changes in brain activation and the reduction in each type of discrepancy using multiple regression analysis. The dependent variables were changes in brain activation between pre-intervention and post-intervention (post – pre). The independent variables included the group effect (mirror exposure = 1, mental imagery = 0), changes in the discrepancy (post – pre; perceived–actual or perceived–ideal discrepancy), the interaction between the group effect and changes in the discrepancy, and the confounding factor of the pre-intervention EDI2 score. We examined the significance of the partial regression coefficient of the changes in the discrepancy term to investigate regional neural-activity changes were associated with the reduction in each type of discrepancy. Additionally, we examined the partial regression coefficient of the interaction term to investigate group-specific effects on each type of discrepancy. Uncorrected $p < 0.001$ was considered indicative of statistical significance, corrected for FWE at $p < 0.05$ based on the cluster size.

2.9.1.2 Changes in cross-regional functional connectivity

Data were analyzed using a conventional two-level approach using CONN. Before analyzing cross-regional functional connectivity, we denoised the time-series data derived from the images. Subsequently, we applied band-pass filtering (0.008–0.09

Hz) and removed possible confounding factors, including motion artifacts and white-matter, cerebrospinal-fluid, and task-related effects.

We investigated the functional connectivity from brain regions associated with visual body-image processing, following a similar approach to that of our previous study (6). We created 10-mm spherical seed ROIs for the bilateral extrastriate body area (left: x, y, $z = -49, -75, 5$; right: x, y, $z = 47, -62, 6$) and right fusiform body area (x, y, $z = 42, -36, -30$) based on a previous study that showed involvement of these regions in visual body-image processing (93). These spherical ROIs covered the extrastriate body area and the fusiform body area, both previously identified in fMRI studies focusing on body-image disturbance (18–20, 35).

We conducted a first-level analysis to determine the connectivity between the seed ROIs (i.e., bilateral extrastriate body areas and the right fusiform body area) and whole-brain voxels. Then, in the second-level analysis, we performed multiple regression analysis. The contrasts and regression model used in the second-level analysis were similar to the analyses for regional neural activity. The dependent variables were changes in functional connectivity from the seed ROIs to whole-brain voxels. We assessed the significance of the partial regression coefficients for the changes in the discrepancy and interaction terms. The significance threshold was set at uncorrected $p < 0.001$, corrected for FWE at $p < 0.05/3$ to account for the repetition of tests involving three seed ROIs based on the cluster size.

2.9.2 Analyses of specific brain regions based on our previous findings

2.9.2.1 Changes in regional neural activity

We also performed an ROI analysis based on our previous finding to assess whether the regions previously identified as being associated with each type of body-image disturbance exhibited changes in activity due to the reduction in body-image disturbance. These ROIs, derived from our previous study (6), included the left anterior cingulate cortex (x, y, $z = -14, 42, 16$), which is associated with perceived–actual discrepancy, and the right temporoparietal junction (x, y, $z = 42, -56, 22$), which is associated with perceived–ideal discrepancy.

Next, we adopted a conventional two-level approach, in which the first-level analysis was similar to the voxel-wise analysis. In the second-level analysis, we investigated the correlations between changes in brain activation within these ROIs and the reduction in each type of body-image disturbance using multiple regression analysis, applying the same contrasts and the same model as in the voxel-wise analysis. We assessed the significance of partial regression coefficients for the changes in the discrepancy and interaction terms. Given our *a priori* hypothesis, the threshold for statistical significance was set at $p < 0.05$.

2.9.2.2 Changes in cross-regional functional connectivity

Similar to the analysis of regional neural activity, we conducted ROI analysis (ROI-to-ROI analysis) to test our hypothesis using a less stringent threshold for statistical significance. We examined the functional connectivity of the left extrastriate body area with target ROIs, including the left anterior insula (x, y, $z = -40, -2, 14$) and right precuneus (x, y, $z = 6, -72, 40$). We observed that the functional connectivity of the left extrastriate body area was correlated with the perceived–actual discrepancy in the left anterior insula and the perceived–ideal discrepancy in the right precuneus.

Similar to the voxel-wise functional connectivity analysis, denoising was performed before the first- and second-level analyses. The first-level analysis was performed to determine the connectivity between the left extrastriate body area and target ROIs. The second-level analysis was similar to the whole-brain analysis. Furthermore, the significance of partial regression coefficients for changes in the discrepancy and interaction terms was examined. $P < 0.05$ was considered indicative of statistical significance.

2.9.2.3 Verification of previous findings

We confirmed our previous findings (6) using the pre-intervention fMRI data obtained in the present study.

In the second-level analysis of regional neural activity, we confirmed the correlations of brain activation with the perceived–actual and perceived–ideal discrepancies observed in our previous study (6). Multiple regression analysis was performed using pre- and post-intervention contrast images; (pre-intervention [actual-body task – control task]) and (pre [ideal-body task – control task]). The dependent variables were brain activation in ROIs, and the independent variables were perceived–actual discrepancy, perceived–ideal discrepancy, participant BMI, and the slope of the logistic curve for the actual- or ideal-body task. Non-target regressors (e.g., perceived–ideal discrepancy was the confounding factor when analyzing the neural response associated with perceived–actual discrepancy), BMI, and the slope of the logistic curve were modelled separately as confounding factors. The threshold of statistical significance was set at $p < 0.05$. The models used for multiple regression analysis were similar to those used in our previous study (6).

The first-level analysis of functional connectivity was performed to determine the connectivity between the seed ROI (i.e., the left extrastriate body area) and the target ROIs (i.e., the left anterior insula and right precuneus). In the second-level analysis, we performed multiple regression analysis using the same contrasts as in the analysis of regional neural activity. The dependent variables were functional connectivity between the seed ROI and targeted ROIs, and the independent variables were perceived–actual discrepancy, perceived–ideal discrepancy, and participant BMI. Non-targeted regressors of the discrepancy (e.g., perceived–ideal discrepancy was the confounding factor when analyzing the neural response associated with the perceived–actual discrepancy) and BMI were modelled separately as confounding factors. Unlike the analysis of regional neural activity, the logistic curve slope was not included in the model because we did not categorize data according to the silhouette size in the functional connectivity analysis. These
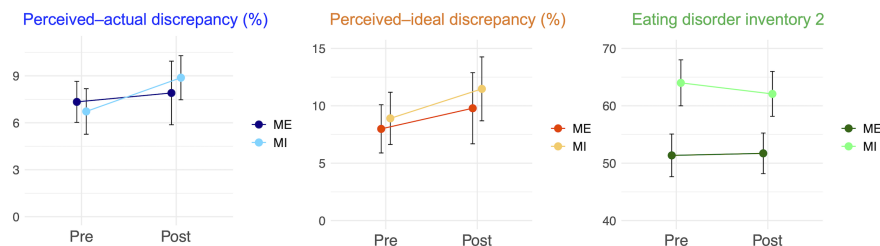
FIGURE 5

Behavioral changes before and after the interventions. Behavioral changes before and after the interventions: perceived–actual discrepancy, perceived–ideal discrepancy, and Eating Disorder Inventory 2 scores are presented. Error bars represent standard error. ME, mirror exposure; MI, mental imagery.

methodologies were similar to those used in our previous study (6). The threshold of statistical significance was set at $p < 0.05$.

3 Results

3.1 Behavioral data

Table 1 and Figure 5 present the pre- and post-intervention changes in behavioral indices. Body-image disturbance was not significantly reduced. The main effects of interventions were not significant (perceived–actual discrepancy: η_p^2 [partial η^2] = 0.02, p = 0.36; perceived–ideal discrepancy: $\eta_p^2 = 0.01, p = 0.40$, EDI2: η_p^2 = 0.001, p = 0.54), implying that there were no significant "group-common" intervention effects on any behavioral indices. Similarly, the interactions between group and interventions were not significant (perceived–actual discrepancy: $\eta_p^2 = 0.004, p = 0.65$; perceived–ideal discrepancy: $\eta_p^2 = 0.0004, p = 0.89$; EDI: η_p^2 =

0.002, $p = 0.38$), implying that there were no significant group differences in terms of the effects on behavioral indices.

3.2 Voxel-wise whole-brain analysis

3.2.1 Changes in regional neural activity

Figure 6 and Table 2 present the results of the voxel-based whole-brain analysis of regional neural activity. The analysis revealed a significant group-common effect regarding individual differences in reductions in perceived–actual discrepancy. The post–pre change in the perceived–actual discrepancy was negatively correlated with post–pre activation changes in the left superior parietal lobule and bilateral occipital gyri, irrespective of the intervention group (Figures 6A, B, Table 2). Furthermore, there was a negative correlation between the post–pre change in perceived–actual discrepancy and post–pre activation changes in the right cuneus in the mental-imagery group (Figure 6C, Table 2).
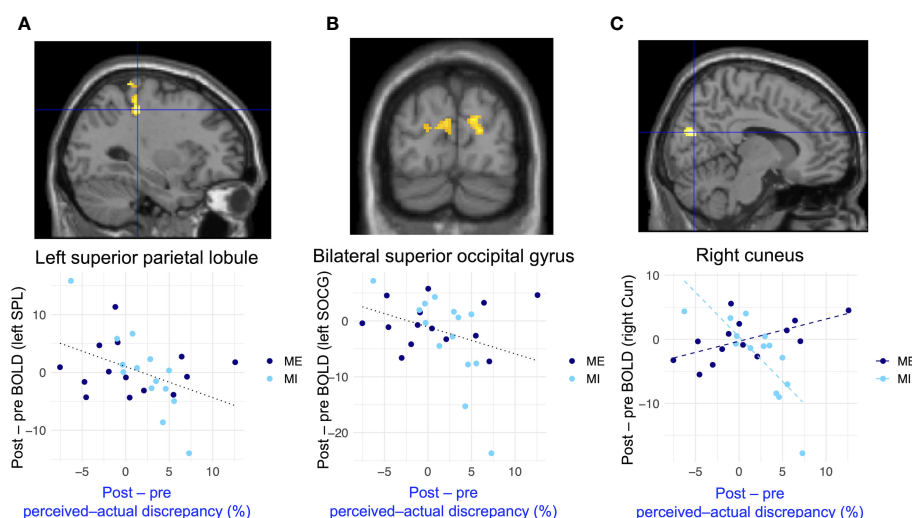
FIGURE 6

Group-common and group-specific neural responses associated with reduced perceived–actual discrepancy detected by whole-brain analysis. **(A, B)** present group-common changes in brain activation associated with reduced perceived–actual discrepancy during the actual-body task. **(C)** shows the group-specific changes in brain activation associated with reduced perceived–actual discrepancy during the actual-body task. There were significant differences between groups regarding changes in brain activation associated with reduced perceived–actual discrepancy. Black dotted lines in the bottom row represent the regression lines for both groups, whereas dashed lines indicate the regression coefficient for each group. BOLD, blood oxygenation level-dependent; SPL, superior parietal lobule; SOCG, superior occipital gyrus; Cun = cuneus.

TABLE 2 Activated brain regions detected by exploratory whole-brain analysis.

Anatomical label	MNI coordinates (peak)				t-value	Cluster	
	L/R	x	y	z		Size (voxels)	Corrected p-value
Changes in regional neural activity							
Contrast: actual-body task > control task							
Common neural response							
Superior parietal lobule	L	-30	-32	46	6.63	268	$p = 0.001$
Superior occipital gyrus	L	-20	-88	24	4.43	153	$p = 0.02$
	R	20	-82	16	4.71	123	$p = 0.04$
Group specific neural response							
Cuneus	R	10	-74	22	5.38	129	$p = 0.04$
Changes in cross-regional functional connectivity							
Contrast: ideal-body task > control task							
Group specific neural response							
Precuneus (from left extrastriate body area)	R	4	-52	56		111	$p = 0.004$

Activation peaks showed significant correlations between reductions in each body-image disturbance and changes in neural responses. There was a main effect of a decrease in perceived–actual discrepancy (group-common changes in regional neural activity) and the interaction between groups (mirror-exposure group vs. mental-imagery group) and the decrease in perceived–actual discrepancy (group-specific changes in regional neural activity). There was a significant interaction between group and the decrease in perceived–ideal discrepancy (group-specific changes in cross-regional functional connectivity). The details of each activation peak are provided, including the MNI coordinates (x, y, z), t-value, cluster size (voxel size = $2 \times 2 \times 2$ mm^3), and corrected p-value. The contrasts were obtained by analyzing the differences between parametrically modulated regressors. The threshold for statistical significance was set at uncorrected p< 0.001, with correction for FWE at p< 0.05 based on the cluster size. L and R indicate the left (L) and right (R) hemispheres, respectively.
MNI, Montreal Neurological Institute.

Participants who experienced a reduction in perceived–actual discrepancy also exhibited increased activation in the left superior parietal lobule and bilateral superior occipital gyri, irrespective of the intervention group, whereas the increase in activation in the right cuneus was observed only in the mental-imagery group. Notably, there were no significant group-common or group-specific neural responses related to the post–pre change in perceived–ideal discrepancy.

3.2.2 Changes in cross-regional functional connectivity

Figure 7 and Table 2 present the results of voxel-based whole-brain functional connectivity analysis. A group-specific effect related to reduction in perceived–ideal discrepancy was observed as a change in functional connectivity from the left extrastriate body area to the right precuneus. A negative correlation was seen in the mirror-exposure group (k = 111, $p = 0.001$; Figure 7, Table 2), indicating that participants in the mirror-exposure group who experienced a reduction in perceived–ideal discrepancy also exhibited an increase in functional connectivity from the left extrastriate body area to the right precuneus. The right precuneus identified in this study did not overlap with the right precuneus identified in our previous study (6). There were no significant group-common effects in the correlations between reduction in body-image disturbance and changes in functional connectivity from the left extrastriate body area. Additionally, there were no significant group-specific changes in functional connectivity related to the decrease in perceived–actual discrepancy.

3.3 Analyses of brain regions identified in previous studies

3.3.1 Changes in regional neural activity

The results of the ROI analysis of regional neural activity are presented in Figure 8. There were significant group-common and group-specific effects on the changes in brain activation in the right temporoparietal junction. The post–pre decrease in perceived–ideal discrepancy was positively correlated with the post–pre activation changes in the right temporoparietal junction ($\beta = 0.25$, $p = 0.02$; Figure 8), and this positive correlation was significantly stronger in the mental-imagery group compared to the mirror-exposure group ($\beta = -0.30$, $p = 0.01$; Figure 8). Participants in the mental-imagery group who experienced a reduction in perceived–ideal discrepancy also exhibited deactivation in the right temporoparietal junction. Conversely, no significant group-common ($\beta = -0.15$, $p = 0.78$; Figure 8) or group-specific ($\beta = 0.54$, $p = 0.40$; Figure 8) effects were observed in the change in brain activation in the left anterior insula.

3.3.2 Changes in cross-regional functional connectivity

The ROI analysis of changes in functional connectivity revealed that there were no significant group-common or group-specific effects. The group-common effects on correlations between the decrease in body-image disturbance and changes in functional connectivity from the left extrastriate body area to target ROIs were not significant (left anterior insula, $\beta = 0$, $p = 0.88$; right precuneus, $\beta = -0.01$, $p = 0.79$). Similarly, there were no significant

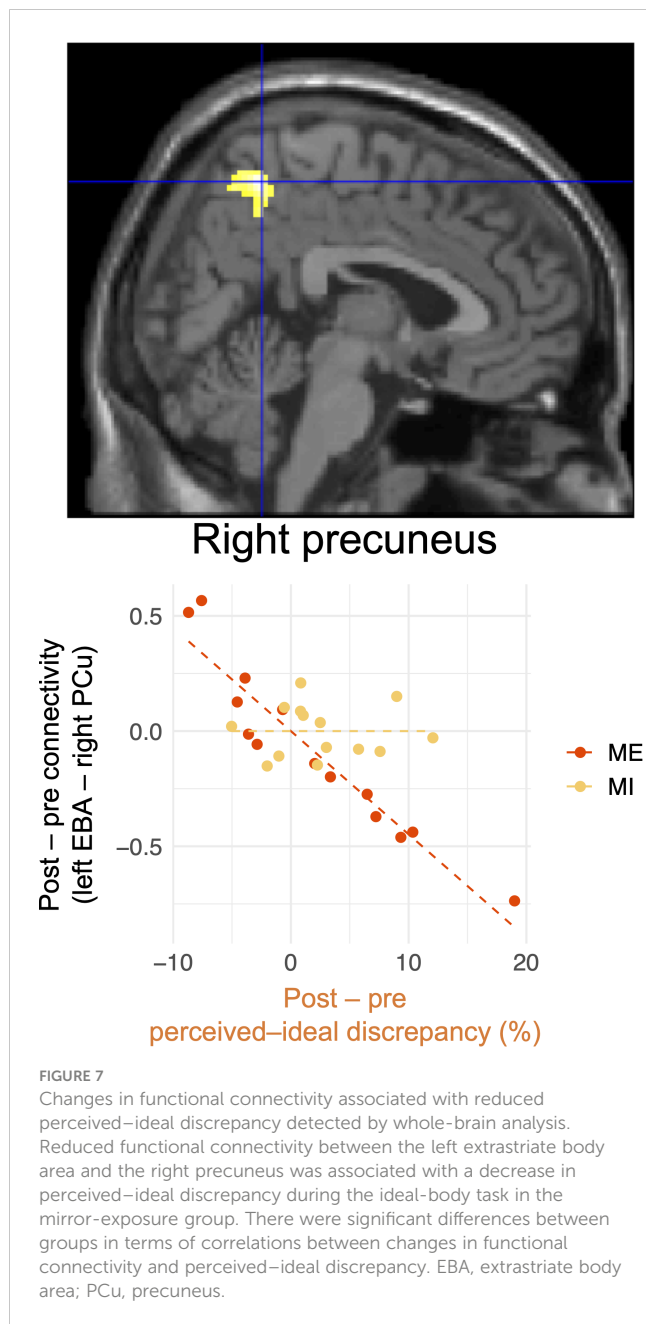**FIGURE 7**
Changes in functional connectivity associated with reduced perceived–ideal discrepancy detected by whole-brain analysis. Reduced functional connectivity between the left extrastriate body area and the right precuneus was associated with a decrease in perceived–ideal discrepancy during the ideal-body task in the mirror-exposure group. There were significant differences between groups in terms of correlations between changes in functional connectivity and perceived–ideal discrepancy. EBA, extrastriate body area; PCu, precuneus.

group-specific effects on correlations between the reduction in body-image disturbance and changes in functional connectivity from the left extrastriate body area to target ROIs (left anterior insula, $\beta = 0.01$, $p = 0.74$; right precuneus, $\beta = 0.01$, $p = 0.72$).

3.3.3 Verification of previous findings

The correlation between perceived–actual discrepancy and left anterior insula was marginally significant ($\beta = 0.41$, $p = 0.08$), whereas that between perceived–ideal discrepancy and right temporoparietal junction was not significant ($\beta = 0.01$, $p = 0.78$).

We failed to replicate our previous findings in the network-level analysis. With regard to pre-intervention contrast images and pre-intervention perceived–actual and perceived–ideal discrepancies, the ROI-to-ROI analysis revealed no significant correlation

between perceived–actual discrepancy and functional connectivity from the left extrastriate body area to the left anterior insula ($\beta = 0.01$, $p = 0.33$). There were no significant correlations between perceived–ideal discrepancy and functional connectivity from the left extrastriate body area to the right precuneus ($\beta = 0.01$, $p = 0.25$).

4 Discussion

We investigated the neural mechanisms underlying the reduction in perceptual and affective disturbances. To reveal these mechanisms, we compared the behavioral and neural indices of non-clinical young women before and after mirror-exposure and mental-imagery interventions. There were no significant behavioral changes after the interventions; however, we identified neural responses related to individual differences in reductions in each type of body-image disturbance. A reduction in perceptual disturbance was associated with increased activation in bodily visuospatial processing regions, such as the left superior parietal lobule, bilateral superior occipital gyri, and right cuneus. On the other hand, a reduction in affective disturbance was related to changes in neural responses in socio-cognitive processing regions, such as decreased activation in the right temporoparietal junction and increased functional connectivity from the left extrastriate body area to the right precuneus. In this study, we tested our hypothesis that changes in attentional and socio-cognitive processing are associated with a reduction in perceptual and affective disturbances, respectively. However, our results provide evidence only for a relationship between socio-cognitive processing changes and a reduction in affective disturbance. Considering the small sample size of the study and the partial replication of our previous findings, our results should be considered preliminary.

4.1 Lack of behavioral improvements after interventions targeting body-image disturbance

There are two possible reasons for the lack of significant behavioral improvements after the interventions. First, the extent of body-image disturbance and body dissatisfaction among the participants might have been insufficient. Previous studies have shown that individuals with stronger body dissatisfaction exhibit greater improvements following interventions (46); thus, participants with less body-image disturbance and body dissatisfaction would exhibit smaller improvements. To select participants with significant body-image disturbance and body dissatisfaction, we recruited individuals with BMI-based perceived–ideal discrepancy values > 2. However, there were no significant correlations between BMI-based perceived–ideal discrepancy in the pre-screening test and silhouette-based perceived–ideal discrepancy in the main experiment (r = −0.02, $p = 0.90$). As a result, the perceived–ideal discrepancy was similar to our previous studies (6, 15), implying that we failed to recruit individuals with greater body-image disturbance. The lack of a significant correlation between BMI-based perceived–ideal
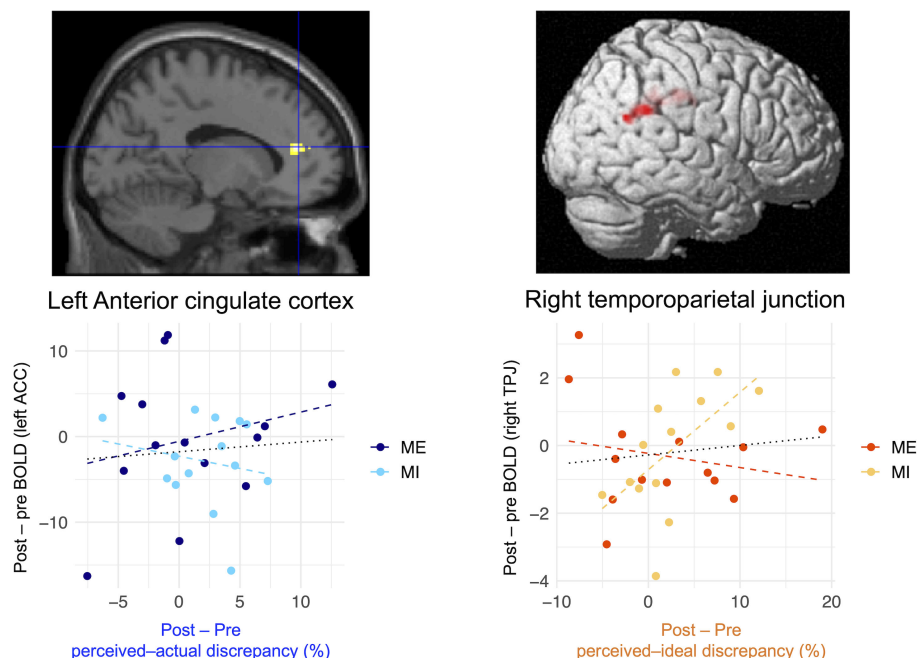
FIGURE 8

Correlation between changes in brain activation in the ROIs and the reduction in each body-image disturbance. Multiple regression analysis demonstrated that changes in brain activation in the right temporoparietal junction were positively correlated with a reduction in perceived–ideal discrepancy in both groups; this effect was significantly stronger in the mental-imagery group. Conversely, there were no significant associations between changes in brain activation and reduction in perceived–actual discrepancy. Scatter plots were created to visualize the results. Black dotted lines in the bottom row represent the regression lines for both groups, whereas dashed lines represent the regression coefficients for each group. Brain images were adapted from a previous study (6). BOLD, blood oxygenation level-dependent; ACC, anterior cingulate cortex; TPJ, temporoparietal junction.

discrepancy and silhouette-based perceived–ideal discrepancy may be attributable to the BMI range in the pre-screening test. The BMI range covered by the 3D images was 16.5–24.5 kg/m^2 (66), but three study participants had a BMI outside of this range. Moreover, eight participants selected the largest body as their own body or the smallest body as the ideal body, implying that these 3D images did not accurately reflect participants' perceived and ideal images. Therefore, future studies should conduct pre-screening tests using the same task as the one used in the main experiment of this study.

Second, it is possible that the intervention was not administered for a sufficiently long duration. We selected the intervention duration based on a previous study that demonstrated that body dissatisfaction was reduced after 30-min exposure to one's own body (43). Considering cultural differences in body images, differences may also exist in the time required to reduce body dissatisfaction (94, 95). It is possible that participants felt greater uneasiness regarding their body during the interventions (96). Additionally, 1-day interventions may not be sufficiently long to reduce body-image disturbance. We conducted 1-day interventions to reduce body-image disturbance based on previous studies that demonstrated reduced questionnaire scores regarding body-image concerns (46, 47). However, several studies administered relatively long interventions lasting for several weeks (41–43). Thus, it is possible that the effects of our interventions were weakened by their short duration and lack of repetition. To examine these factors, further studies are needed to determine the effects of 1-day

interventions with longer duration as well as the influence of body uneasiness.

4.2 Changes in neural responses related to reduction in perceptual disturbance

Our results imply that increased activation in the visuospatial processing regions when estimating one's body size is associated with a reduction in perceptual disturbance. We found that increased activation in the left superior parietal lobule, bilateral superior occipital gyri, and right cuneus was associated with a decrease in perceived–actual discrepancy during the actual-body task. Notably, there was significantly increased activation in the right cuneus in the mental-imagery group. The left superior parietal lobule is involved in bodily visuospatial processing (97), and people with eating disorders exhibit less brain activation in the left superior parietal lobule when viewing their own body (98). The superior occipital gyrus and right cuneus are also involved in bodily visuospatial processing (99–102). In line with the previous finding that brain activation in visual-processing regions declines in people with eating disorders (3, 18–20), we found a significant inverse relationship between perceptual disturbance and brain activation in regions involved in bodily visuospatial processing. These findings imply that perceived–actual discrepancy is decreased due to greater visuospatial processing when estimating one's body size. These

group-common relationships between changes in brain activation in regions involved in bodily visuospatial processing and the decrease in perceived–actual discrepancy are attributable to the use of objective expressions rather than avoiding negative expressions. When participants in both interventions described the shape of their body parts, they were encouraged to use objective expressions, such as describing proportion and length. Participants who experienced a decrease in perceived–actual discrepancy likely considered their body image objectively during the actual-body task, which may have been reflected in increased activation in bodily visuospatial processing regions.

The group-specific neural responses seen in this study imply that mental imagery is more effective than mirror exposure in reducing perceptual disturbance. As demonstrated in Figure 6C, brain activation in the right cuneus increased with a decrease in perceived–actual discrepancy in the mental-imagery group. Moreover, as shown in Figures 6A, B, group-common neural responses related to the reduction in perceived–actual discrepancy were mainly observed in participants in the mental-imagery group. Although the interaction did not reach statistical significance, the neural responses in the left superior parietal lobule and bilateral superior occipital gyri may also be associated with the effect of mental imagery rather than representing group-common effects, similar to the neural response in the right cuneus. With regard to the acute effects of single-session interventions, it is suggested that mental imagery contributes to reduced perceptual disturbance and enhancement of visual processing. During mental imagery, participants imagined a specific body part and considered how to describe it. Thus, participants had to recollect their body parts, leaving limited time and cognitive resources for negative feelings toward these body parts. Additionally, participants in the mental-imagery group may have imagined their body part from both a first-person and mirror-like point of view, potentially enhancing their real-time perception-driven inputs when estimating their body sizes rather than relying on attitudes and beliefs related to their bodies (103). The specific improvements in bodily visual processing were mainly derived from mental imagery, implying that interventions can be conducted with a relatively low risk of side effects to prevent misestimation of one's body size. Mental imagery would be less harmful because, compared to exposure therapies, it is less likely to increase body-image concerns (20, 43, 49). Additionally, mental imagery does not require special tools, such as a full-length mirror, and paradigms can be conducted online. Therefore, future research investigating the relationship between perceptual disturbance and mental imagery can be conducted online, enabling the recruitment of more participants from a wider population.

The brain regions related to the reduction in perceptual disturbance imply that perceptual disturbance is not caused solely by visual processing problems, as relatively higher visual processing is related to a reduction in perceptual disturbance. We observed involvement of the left superior parietal lobule, bilateral superior occipital gyri, and right cuneus. Our results are consistent with the conventional hypothesis that perceptual disturbance is related to visual processing areas, such as the extrastriate body area, fusiform body area, and parietal lobule (3, 18–20, 104). The brain regions related to the reduction in perceptual disturbance are also involved

in middle- to higher-order visual processing, including multisensory integration (105–108). We extracted neural responses specific to body image by subtracting the actual-body and control task data; thus, the neural response included recognizing that the presented stimulus was one's own body. Therefore, certain higher cognitive functions specific to one's own body, such as multisensory integration, are associated with a reduction in perceptual disturbance rather than bottom-up solely visual processing changes. This observation is consistent with our previous assumption that neural mechanisms underlying perceptual disturbance are not solely reliant on simple visual processing (6).

4.3 Changes in neural responses related to reduction in affective disturbance

With regard to neural responses related to reduction in affective disturbance, both regional neural activity and cross-regional functional connectivity imply the involvement of socio-cognitive processing. ROI analysis revealed that the brain activation in the right temporoparietal junction decreased with a reduction in perceived–ideal discrepancy, consistent with our previous finding that the right temporoparietal junction was positively correlated with perceived–ideal discrepancy (6). Additionally, whole-brain functional connectivity analysis demonstrated that the functional connectivity between the left extrastriate body area and the right precuneus increased with a reduction in perceived–ideal discrepancy. This finding is also consistent with our previous result that functional connectivity from the left extrastriate body area to the right precuneus was negatively correlated with perceived–ideal discrepancy. The right temporoparietal junction and right precuneus are associated with socio-cognitive processing, such as thinking about others' thoughts (30, 31, 109–111). The similar results between our present and previous studies provide additional evidence of the neural relationship between affective disturbance and socio-cognitive processing, which is conceptually consistent with the widely accepted model of the development of body-image disturbance (32).

Our findings of group-specific neural responses imply that both interventions were effective in reducing affective disturbance, although different mechanisms might be involved in each intervention. Despite the significant group effects, Figure 4B demonstrates that the relationship between deactivation in the right temporoparietal junction and the reduction in perceived–ideal discrepancy was stronger in the mental-imagery group. On the other hand, the correlation between the reduction in perceived–ideal discrepancy and changes in functional connectivity from the left extrastriate body area to the right precuneus were stronger in the mirror-exposure group. We previously inferred that higher activation in the right temporoparietal junction and lower functional connectivity from the left extrastriate body area to the precuneus were associated with thoughts about ideal body images prevalent in society. However, this study demonstrated that these neural responses were influenced by different interventions, implying that each neural response reflects distinct psychological

processes. Regarding the differences between mirror exposure and mental imagery, mirror exposure is a more visually focused intervention. It is possible that reduced visual input related to one's body during mental imagery allowed the participants to concentrate on objectively evaluating their bodies without any increase in body dissatisfaction. Conversely, mirror exposure may reduce body-image concerns, as suggested by a previous report that mirror exposure reduces the frequency of negative thoughts and feelings of ugliness compared to mental imagery (42). Future studies should evaluate other indices of body-image concerns as well as perceived–ideal discrepancy.

Our findings that the changes in the right temporoparietal junction and functional connectivity between the left extrastriate body area and the right precuneus varied between the different interventions imply distinct roles of these regions in body-image processing. Based on previous studies, we hypothesized that the precuneus is closely related to body-specific socio-cognitive processing. Both the temporoparietal junction and precuneus are related to socio-cognitive processing, including understanding others' thoughts (30, 109–111); however, only the precuneus participates in contemplation of others' evaluations and descriptions regarding the appearance of one's own body (31). A previous study compared neural responses when participants evaluated their own body parts (e.g., "I think my arms are bony") and when they surmised evaluations of their body parts by their friends (e.g., "My friend thinks my neck is slender"). Therefore, the decreased activation in the right temporoparietal junction in the mental-imagery group may indicate that participants stopped contemplating vague evaluations from others, such as "beautiful", "ideal", or "unpreferable". On the other hand, the increase in functional connectivity between the left extrastriate body area and the right precuneus in the mirror-exposure group indicates that participants stopped thinking about the evaluations of others regarding specific body parts. In line with this, a previous study demonstrated that mirror exposure reduces the frequency of negative thoughts and feelings of ugliness compared to mental imagery (42). Considering that both the temporoparietal junction and precuneus are related to the expression of affective disturbance (6), neural response changes in both regions could be equally important. Therefore, to address both processing aspects, conducting both mirror exposure and mental imagery could be effective. A previous study conducted mirror exposure in a laboratory with an experimenter, and participants were asked to engage in mental imagery at home (43). Such an approach may be the most effective for reducing the affective component.

4.4 Academic and clinical contributions

Our results reveal both differences and similarities between the neural mechanisms associated with a reduction in body-image disturbance and the degree of body-image disturbance. In our previous study, we found a positive correlation between activation in the left anterior cingulate cortex and perceived–actual discrepancy (6), which was replicated in the present study. However, in this study, we did not observe significant

deactivation in this region accompanied by reduction in perceived–actual discrepancy. Instead, we identified increased activation in regions associated with bodily visuospatial processing. This inconsistency implies that the neural mechanisms related to the expression of perceptual disturbance differ from those related to its reduction. Attentional processing may influence the degree of perceptual disturbance, whereas bodily visuospatial processing could be related to its reduction. This challenges the assumption that perceptual disturbance is related solely to bodily visuospatial processing, which has been made in several fMRI studies that compared people with eating disorders and healthy individuals (3, 20, 26–28). These studies have revealed differences in neural responses in bodily visuospatial processing regions between people with eating disorders and healthy individuals. Our results imply that the neural responses observed in previous studies represent development or reduction of perceptual disturbance rather than neural responses related to the degree of perceptual disturbance.

Unlike perceptual disturbance, expression and reduction of affective disturbance share a common neural mechanism. We observed changes in neural responses associated with a reduction in perceived–ideal discrepancy in brain regions where we had previously identified neural responses that correlated with perceived–ideal discrepancy (6). In particular, we observed that reduced activation in the right temporoparietal junction, and increased functional connectivity between the left extrastriate body area and the right precuneus, were accompanied by a decrease in perceived–ideal discrepancy. These results imply that socio-cognitive processing is related to both expression and reduction of affective disturbance, implying that changes in affective disturbance are intertwined with socio-cognitive processing. Therefore, our results imply that perceptual and affective disturbances develop, persist, and change independently. These results also provide information useful for the development of biomarkers for the prevention and treatment of each component of body-image disturbance, as well as novel interventions that directly manipulate neural responses. Moreover, our findings imply that, as observed previously, the neural mechanisms underlying the expression of each type of body-image disturbance are relatively robust, as evidenced by the replication of the results regarding the left anterior cingulate cortex and the neural mechanisms underlying the reduction in affective disturbance.

Another clinical implication of our study is the potential for improving intervention instructions. We did not observe significant behavioral improvements related to body-image concerns. One common aspect of the two interventions was the instruction to avoid negative expressions when describing one's body. Consistent with previous studies (41, 46), we encouraged participants to avoid using subjective expressions, including both positive (e.g., "beautiful" and "like") and negative expressions. Instead, participants were encouraged to use objective neutral expressions related to length, color, and ratio. However, our non-significant results imply that, instead of encouraging the use of objective neutral expressions, positive expressions should be encouraged, although they are subjective. Some participants described the size and length of their body parts in comparison to other objects, which

could increase body-image concerns despite the lack of use of negative expressions. Moreover, it has been reported that the use of positive subjective expression when describing one's body is associated with reduced body-image concerns (43, 48, 49). Therefore, mirror exposure and mental imagery would be improved by instructing participants to avoid subjective negative expressions and encourage positive ones.

4.5 Limitations

This study had several limitations. First, we could only partially replicate the findings of our previous study, which investigated the neural responses associated with each type of body-image disturbance. We did not observe a positive correlation between perceived–actual discrepancy and functional connectivity from the left extrastriate body area to the left anterior insula, a positive correlation between perceived–ideal discrepancy and the right temporoparietal junction, or a negative correlation between perceived–ideal discrepancy and functional connectivity from the left extrastriate body area to the right precuneus. The most likely reason for our inability to replicate these results is the limited sample size. In our previous study, we analyzed data from 36 women, whereas in the current study, we analyzed data from only 28 women. However, we do not think that the previous findings were obtained by chance, as some of them were indirectly supported in the current study. This study showed reduced activation in the right temporoparietal junction in association with decreased perceived–ideal discrepancy in the mental-imagery group (Figure 4B). Additionally, the mirror-exposure group demonstrated increased functional connectivity from the left extrastriate body area to the right precuneus, associated with a decrease in perceived–ideal discrepancy (Figure 7). Although a replication study with a similar sample size to our previous study is warranted, the present results should be considered consistent with those of the previous study.

Second, the lack of significant collective behavioral improvements warrants discussion, even though our primary objective concerning neural mechanisms was achieved through individual analysis. We have considered two possible explanations: 40-min interventions were not sufficiently long to reduce body-image disturbance for Japanese individuals, or 1-day interventions were not sufficiently effective. Brief interventions are highly valuable considering the worldwide shortage of mental health workers (112, 113), particularly in situations such as pandemics where in-person visits are limited. Therefore, it is crucial to determine whether brief interventions can reduce body-image disturbance without the need for repeat visits over several weeks. In future studies, the duration of interventions should be extended, and their effects should be examined in a larger population. Comparison with long-term interventions spanning several weeks would provide useful information. Additionally, this study investigated only the acute effects of interventions; therefore, the long-term effects of interventions should be investigated in future studies.

Third, our sample size was small. We analyzed 36 participants in our previous fMRI study evaluating individual differences (6), whereas

this study enrolled only 28 participants. Although our sample size is not excessively small compared to recent fMRI studies investigating individual differences (114, 115), it was not sufficiently large to ensure replicability (116). However, we believe that our results were relatively robust because they are in line with those of our previous study (6) and other studies (3, 18–20). The small sample size may have contributed to the non-significant behavioral improvements. In the present study, the main effect of intervention on perceived–actual and perceived–ideal discrepancies was small according to conventional effect size classifications (small, 0.01–0.05; medium, 0.06–0.13; large, > 0.14) (117). The largest effect size was $\eta_p^2 = 0.02$. We calculated the number of participants required for adequate power based on the effect size from ANCOVA using G*Power 3.1 (118). Power analysis using G*Power with $\eta_p^2 = 0.02$ (the largest effect size for the main effect of intervention on the perceived–actual discrepancy), $\alpha = 0.05$, and power = 0.8 demonstrated that 387 participants would be needed. Considering that previous studies involving short-term interventions reported significant results with< 100 participants, our study may not have appropriately estimated the effect size of the interventions. Furthermore, *post-hoc* power analysis for the analysis of covariance using G*Power 3.1 (118) based on the main effect of intervention revealed a power of 0.11 for perceived–actual discrepancy, 0.08 for perceived–ideal discrepancy, and 0.05 for the EDI2 score. Based on the interaction effect, the power was 0.06 for perceived–actual discrepancy, 0.05 for perceived–ideal discrepancy, and 0.06 for the EDI2 score. These results also imply that our sample size was not sufficiently large to accurately estimate effect sizes. Thus, in both the neurological and behavioral context, future studies with larger sample sizes are needed.

Fourth, the age range was another study limitation. Our results are probably applicable to late adolescents (aged around 18 years), as suggested by a previous study that found that body-image disturbance in women aged 17–40 years did not decline with age (59). However, early and middle adolescents are the most likely to develop eating disorders (2). Additionally, there is growing interest in exploring body-image disturbance in other groups, such as men and transgender individuals (62, 119). Future research should involve more diverse groups, including patients, men, those with other gender identities, and early to middle adolescents as well as people with eating disorders.

Fifth, we did not control for education level, which influences body perception and body dissatisfaction (120, 121). Even though only four participants were from outside the university, it could influence our results considering our small sample size. Nevertheless, this would affect the generalizability of our results. To enhance generalizability, future studies should control for the socioeconomic status and education level of participants recruited from the general population.

Finally, our stimuli could not investigate changes in participants' estimates of their body circumference, tone, and curviness. A previous study demonstrated that virtual-reality-based interventions improved the ability to estimate one's body circumference (122). Moreover, the ideal body image is diverse, including toned and curvy bodies (60). However, the silhouette image used in the present study can be employed only to estimate body width; 3D body images are needed to examine the ability to estimate body size, including circumference, muscle, and curviness,

in an MRI scanner. Future studies should use similar stimuli to investigate the effects of interventions on the ability to estimate the body circumference.

5 Conclusions

This study identified neural responses related to reduced body-image disturbance. Participants who demonstrated such a reduction also exhibited changes in brain activation. Decreased perceptual disturbance was associated with increased activation of bodily visuospatial processing regions, including the left superior parietal lobule, bilateral superior occipital gyri, and right cuneus. On the other hand, reduced affective disturbance was associated with changes in neural responses in socio-cognitive processing regions, including decreased activation in the right temporoparietal junction and an increase in functional connectivity from the left extrastriate body area to the right precuneus. These results partially support the results of our previous studies investigating the neural responses associated with each type of body-image disturbance, implying significant differences in neural mechanisms between reduction and expression of body-image disturbance. Although we observed neural responses related to the effects of interventions at the individual level, we did not detect significant collective behavioral improvements. In conclusion, our results enhance our understanding of the neural mechanisms underlying body-image disturbance and could inform the development of treatment and prevention methods for eating disorders.

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 Tohoku University Graduate School of Medicine. 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

YH: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Software, Visualization, Writing – original draft, Writing – review & editing. KO: Investigation, Writing – review & editing. RI: Investigation, Writing – review & editing. YD: Investigation, Writing – review & editing. RN: Investigation, Writing – review & editing. MS: Conceptualization, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing.

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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 author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

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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.2024.1337776/full#supplementary-material

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Characteristics of attentional bias in adolescents with major depressive disorders: differentiating the impact of anxious distress specifier

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Background: No consistent conclusion has been reached regarding the attentional bias characteristics of adolescents with major depressive disorders (MDD), and unexamined co-occurring anxiety distress may contribute to this inconsistency.

Methods: We enrolled 50 MDD adolescents with anxiety distress, 47 MDD adolescents without anxiety distress and 48 healthy adolescents. We measured attentional bias using a point-probe paradigm during a negative-neutral emotional face task. Reaction time, correct response rate and attentional bias value were measured.

Results: MDD adolescents did not show a negative attentional bias; MDD adolescents with anxiety distress exhibited longer reaction time for negative and neutral stimuli, lower correct response rate for negative stimuli. Hamilton Anxiety Scale scores were positively correlated with reaction time, negatively correlated with correct response rate, and not significantly correlated with attentional bias value.

Limitations: The cross-sectional design hinders causal attribution, and positive emotional faces were not included in our paradigm.

Conclusion: Negative attentional bias is not a stable cognitive trait in adolescents with MDD, and avoidance or difficulty in disengaging attention from negative emotional stimuli may be the attentional bias characteristic of MDD adolescents with anxiety distress.

1 Introduction

Major Depressive Disorders (MDD) are a class of mental disorders characterized by the presence of significant and persistent low mood. In 2008, the World Health Organization listed MDD as the third leading contributor to the global burden of disease and predicted that by 2030, MDD will become the primary contributor (1, 2). The lifetime prevalence of adolescent MDD has been reported to be as high as 11.4% (3). Due to factors such as poor family environment, tense parent-child relationships, and high pressure to succeed in education, the incidence of depressive disorders among adolescents in China is increasing year by year. According to the *China National Mental Health Development Report* (2019-2020), the prevalence of depressive disorders among adolescents in China is 24.6%, with 7.4% classified as major depression. While MDD itself seriously affects academic performance and quality of life in adolescents, anxious distress is a prominent feature of MDD; moreover, high levels of anxiety have been associated with an increased risk of suicide, longer disease duration, and the likelihood of ineffective treatment (4, 5). The condition has been labeled 'anxious distress specifier (ADS) for major depressive disorder' in the U.S. version of the Diagnostic and Statistical Manual of Mental Disorders, 5th Edition (DSM-V) (6, 7). Patients with major depressive disorder with ADS reported more severe depressive symptoms, a higher number of hospitalizations, elevated rates of suicidal ideation, increased illness severity, greater work impairment, diminished quality of life, and self-perceived cognitive impairment (8, 9). Currently, several groups have reported significant differences in hypothalamic–pituitary–adrenal axis function, structural and functional brain imaging, and inflammatory markers between MDD subgroups with and without ADS (10). However, our research on the pathophysiological mechanisms of ADS is insufficient, especially the research on the special group of adolescents. We need to dig deeper into the characteristics of ADS and propose potential mechanisms for the poor prognosis associated with ADS as its presence identifies a subpopulation with greater illness-associated burden and hazards.

Attentional bias (AB) refers to selective attention when receiving external information due to an increased sensitivity to specific types of stimuli/information (11). Some studies have found that patients with MDD exhibit attentional bias toward negative information, which manifests as prioritizing negative stimuli and avoiding the allocation of attention to positive stimuli (12–14). In addition to an initial attention bias, a research has revealed that individuals with depression exhibit a negative bias in the processing and memory of information (15). Specifically, compared to their healthy counterparts, patients with depressive disorders demonstrate a heightened tendency to quickly process and sustain negative information, while experiencing difficulty in effectively utilizing positive memories to regulate feelings of sadness (16). Therefore, some scholars have proposed a hypothesis that selective attention to negative information may be a significant contributing factor in the onset, persistence, and development of depressive symptoms (17–19). Based on this hypothesis, researchers have targeted altering initial attentional bias as a key focus in the

treatment of depressive disorders and have developed various attentional bias modification training techniques. However, the intervention effects have proven to be unclear (19, 20). This situation compels us to reevaluate the attentional bias characteristics of individuals with depressive disorders.

Indeed, while some researchers support the notion that negative attentional bias is a characteristic of individuals with depressive disorders, there have always been dissenting voices in the field. In one dot-detection task (21), simultaneously presented emotional and neutral faces, reporting no differences between the depression and healthy control groups in the early course of attentional allocation, as well as in the attentional bias in response to sad, happy, and angry faces. Cheng et al. (22) conducted five independent experiments using task paradigms capable of triggering attentional bias in participants with depression, including selective attention, attentional switching, and attentional suppression tasks. Patients with MDD performed similarly to healthy controls, leading the authors to conclude that depression is not characterized by biased attentional processes. Another group also found no direct correlation between negative attentional bias and depressive symptoms (23). Harrison and Gibb (24) conducted a study using eye-tracking technology to investigate attentional bias characteristics in children with depression (with an average age of 11.21 years). The results revealed that children with depressive disorders exhibited attentional avoidance of sad facial stimuli while showing a preference for attending to happy faces. Therefore, there is significant disagreement among current research findings regarding attentional bias characteristics in patients with Major Depressive Disorder, particularly in underage patients. This highlights the need for further and more in-depth research in this area.

Among studies examining relationships between affective disorders and attentional bias, research on anxiety disorders is consistent. Adults with anxiety disorders have shown selective attention to threatening stimuli (25). Zhang et al. (26) found patients with anxiety disorder had attentional bias at the early stage. Kim et al. (27) found that individuals with social anxiety disorder exhibit persistent attentional bias to task-irrelevant social threats. They also proposed that the underlying mechanism for this attentional bias involves excessive activation of the amygdala and sustained activity in the bottom-up attentional networks. A systematic review of studies on attentional bias in children with anxiety disorder (28) reported that, among 4,221 participants (anxiety, $n = 2,222$), those with anxiety disorder had attentional bias values similar to those observed in adults when presented with threatening stimuli, albeit to a lesser extent.

In brief, anxiety is characterized by attentional bias to threat, but findings are inconsistent for depression. As we all know, MDD and anxiety often co-occur in children and adolescents (29). The presence of anxiety distress is likely to have an impact on attentional bias characteristics in individuals with MDD. Previous literature provides inconsistent evidence regarding the attentional bias in depression, and unexamined co-occurring anxiety distress may contribute to this inconsistency. Therefore, when studying attentional bias characteristics in MDD, it is essential to differentiate whether co-occurring anxiety distress is present. Our

research aims to assess the role of anxiety distress in attentional bias among adolescents with MDD. If adolescents with MDD exhibit different attentional bias characteristics based on the presence or absence of anxiety distress, we can develop customized attention bias modification interventions targeting these subgroups, thus contributing to a more personalized and tailored treatment approach for adolescents with MDD.

2 Materials and methods

2.1 Patients

Using the sequential enrollment method, we recruited 97 adolescent patients with MDD who had been hospitalized in the Department of Children and Adolescents at Anhui Mental Health Center between September 2021 and April 2022. The inclusion criteria were: 1) meeting the diagnostic criteria for MDD as listed in the DSM-V; age 13 to 18 years; right-handed; and no obvious impairments in vision or hearing.

We excluded patients with neurological disease, serious physical disease, psychoactive substance abuse, intellectual disability, or an inability to complete the experimental tasks.

A Hamilton Anxiety Scale (HAMA) (30, 31) score greater than or equal to 14 was used to divide adolescents with MDD into MDD/ADS+ ($n = 50$) and MDD/ADS- subgroups ($n = 47$). MDD/ADS+ stands for MDD adolescents with anxiety distress; MDD/ADS- stands for MDD adolescents without anxiety distress.

A total of 48 healthy adolescents matched to the MDD group for age, sex, and years of education were recruited from two general middle schools in Hefei City, Anhui Province. They voluntarily participated in the study, with the same exclusion criteria as in the patient group. The general characteristics of each group are shown in Table 1.

2.2 Informed consent and confidentiality

The study protocol was reviewed and approved by the Ethics Committee of Anhui Mental Health Center. All participants and/or their guardians were conscious of the content and purpose of the

study. All agreed to and signed the informed consent form. We confirmed that all methods were performed in accordance with the relevant guidelines and regulations.

2.3 Methods

The two psychiatrists who assessed the participants were professionally trained and qualified to rate the neuropsychological tests and related scales, with guidance and training provided by the Cognitive Psychology Laboratory jointly established by the Anhui Mental Health Center and Anhui Medical University. Each participant completed the Hamilton Anxiety Scale and attentional bias tests described below. To minimize the interference of hospitalization duration on the study results, all assessments were conducted within one week after patients' admission. In order to ensure consistency, the assessments for both patients and healthy adolescents were carried out by two trained psychiatrists, who were not the patients' treating clinicians.

2.3.1 Hamilton anxiety scale

This test includes 14 items. The total score is designed to reflect the severity of anxiety symptoms with reliability and validity.

2.3.2 Attentional bias test

A point-detection paradigm was used with reference to the attentional bias measurement program written by Prof. Xuemin Zhang's team at the School of Psychology, Beijing Normal University, written using E-Prime 3.0 experimental software (32). The attentional bias determination task was comprised of four steps:

- A "+" gaze point appeared at the center of the computer screen for 500 ms.
- A face picture (neutral or negative) appeared on each side of the gaze point for 500 ms. The pictures were 16 selected from the Chinese Affective Face Picture System (33); half were negative and half were neutral. Half were male, half were female.
- The response target was a capital letter "E" or "F" displayed on the screen. After the pictures disappeared, the response target appeared on either the left or right side of the gaze point for 500 ms, at one of the positions in the previous pictures. At the same time, the participants were asked to put their left index finger on the "E" key and their right index finger on the "F" key and to ensure that neither finger left the keyboard during the experiment.
- When the target appeared, participants were instructed to press the corresponding key on the keyboard as quickly and accurately as possible, with a maximum threshold time of 2,000 ms.
- The center of the screen then turned blank for 1,000 ms, indicating that participants should prepare for the next round.

The attentional bias task consisted of 8 practice sessions and 128 test sessions, which took approximately 8 minutes to complete the process. The computer recorded each response. At the end of the

TABLE 1 Characteristics of study participants.

	MDD/ADS+	MDD/ADS-	HC	Metrics
n	50	47	48	
Sex (M:F)	17:33	18:29	19:29	$\chi^2(2) = 0.360$, $P = 0.835$
Age	14.78 ± 1.52	15.21 ± 1.43	14.71 ± 1.49	$F = 1.619$, $P = 0.202$
Years of Education	9.74 ± 1.67	10.36 ± 1.51	9.73 ± 1.75	$F = 2.310$, $P = 0.103$
HAMA	22.52 ± 5.90	8.23 ± 3.28	0.00 ± 0.00	$F = 411.899$, $P = 0.000$

MDD/ADS+, MDD adolescents with anxiety distress; MDD/ADS-, MDD adolescents without anxiety distress; HC, healthy control group; HAMA, Hamilton Anxiety Scale.

assessment, we calculated average response time (RT), correct response rate (CRR), and attentional bias values (AB value) for the negative and neutral pictures. The attentional bias value was calculated by subtracting the average RT for neutral pictures from that for negative pictures. Larger attentional bias values indicated a more significant attentional bias.

2.4 Statistical methods

Data were analyzed using SPSS 24.0 (34). Comparisons among the three groups were performed using the χ^2 test for sex and analysis of variance (ANOVA) for age, years of education, and HAMA scores. RT, CRR, and AB values did not conform to normal distributions using the Shapiro-Wilk test (35), the parameters of which are provided in the Appendix. Therefore, we used nonparametric tests, using the median for statistical descriptions.

To evaluate the difference of single metric (i.e. RT, CRR and AB values) between the three groups, we implement the Kruskal-Wallis test. Additionally, the Wilcoxon signed-rank test was conducted intra-group to compare the RT and CRR for the negative and neutral pictures. Spearman correlation analysis was also performed. Differences with $P < 0.05$ were considered statistically significant.

3 Results

3.1 Comparisons of RT, CRR, and AB values

Table 2 shows the results of the multiple independent samples Kruskal–Wallis test for the five indicators in each group: Neg-RT, Neu-RT, Neg-CRR, Neu-CRR, and AB value. Significant differences among groups were observed for Neg-RT, Neu-RT, and Neg-CRR ($P < 0.05$) but not for AB value or Neu-CRR ($P > 0.05$). Dunn's test was used to further compare pairs with differences (Table 3). Neg-RT and Neu-RT were significantly higher in the MDD/ADS+ group than in the MDD/ADS- and HC groups ($P < 0.01$), while Neg-CRR was significantly lower in the MDD/ADS+ group than in the MDD/ADS-group ($P < 0.05$). Figure 1 presents a more visual comparison of RT and CRR among the three groups.

3.2 Inter-group RT and CRR comparisons between negative and neutral stimuli

Table 4 shows the results of the Wilcoxon signed-rank test, which was conducted intra-group to compare the RT and CRR for

TABLE 2 Kruskal-Wallis testing for three independent samples.

Metrics	Neg-RT	Neu-RT	Neg-CRR	Neu-CRR	AB value
H	20.961	21.428	8.495	3.366	4.165
df	2	2	2	2	2
P	0.000	0.000	0.014	0.186	0.125

the negative and neutral pictures. Differences in Neg-RT and Neu-RT, Neg-CRR and Neu-CRR within the three groups were not statistically significant ($P > 0.05$).

3.3 Correlation between AB and HAMA scores in adolescents with MDD

Spearman's correlation analysis showed that HAMA scores in the MDD group were positively correlated with Neg-RT and Neu-RT ($r = 0.280$, $P = 0.005$; $r = 0.319$, $P = 0.001$), negatively correlated with Neg-CRR and Neu-CRR ($r = -0.285$, $P = 0.005$; $r = -0.228$, $P = 0.025$), and not significantly correlated with AB value ($P = 0.108 > 0.05$).

4 Discussions

To clarify the role of anxiety distress on the attentional bias of MDD adolescents, we compared the attentional bias characteristics of the MDD/ADS+ group, MDD/ADS- group, and healthy control group. The findings indicate that: adolescents with MDD did not show a negative attentional bias when exposed to negative and neutral stimuli, as evidenced by similar reaction times. Compared to the MDD/ADS-group, the MDD/ADS+ group exhibited longer reaction times for negative and neutral stimuli (Neg-RT, Neu-RT), as well as lower correct response rates for negative stimuli (Neg-CRR). Additionally, there were positive correlations between Neg-RT and Neu-RT with HAMA scores, and negative correlations between Neg-CRR and Neu-CRR with HAMA scores among adolescents with MDD.

Attention includes multiple components, including orienting, maintenance, distraction, and conversion (36). In attentional bias research, we consider attention as a cognitive process that enables the parsimonious and efficient allocation of neuronal processing resources (37). These processes are characterized by their limited capacity and selectivity in terms of which stimuli or features are prioritized and focused on (38, 39). The selection processes can be influenced by both neural mechanisms of top-down attentional control (40) and the inherent stimulus information (41). For humans, facial expressions are prominent nonverbal means of expressing and communicating emotional states (42, 43). People naturally focus on emotional faces. So we use emotional faces as stimulus information in our attentional bias task. Theoretically, the attentional bias effect would be enhanced using emotional faces as stimuli in the attentional bias task. However, we found no statistically significant differences among the groups between negative and neutral reactions or between negative and neutral accuracy, suggesting no attentional bias towards negative stimuli in MDD adolescents or healthy adolescents. This finding seems to be different from the results of many previous studies, and it illustrates that the bias toward negative emotional information is not a characteristic of the attentional processes of MDD adolescents. The point-detection paradigm is an indirect assessment of attentional processes while eye-tracking technology can directly and continuously measure the attentional processing of emotional stimuli by recording eye movements. Our conclusion is consistent

TABLE 3 Pairwise comparison of Neg-RT, Neu-RT and Neg-CRR using Dunn's Test.

	Group A	Group B	Median A	Median B	Diff (A-B)	H	P
Neg-RT (ms)	HC	MDD/ADS-	620.73	641.33	-20.60	-1.123	0.784
	HC	MDD/ADS+	620.73	713.48	-92.75	-4.402	0.000
	MDD/ADS-	MDD/ADS+	641.33	713.48	-72.15	-3.244	0.004
Neu-RT (ms)	HC	MDD/ADS-	628.09	623.39	4.7	-0.472	1.000
	HC	MDD/ADS+	628.09	719.07	-90.98	-4.219	0.000
	MDD/ADS-	MDD/ADS+	623.39	719.07	-95.68	-3.719	0.001
Neg-CRR	HC	MDD/ADS-	95.31%	96.77%	-1.46%	1.154	0.249
	HC	MDD/ADS+	95.31%	93.75%	1.56%	2.900	0.745
	MDD/ADS-	MDD/ADS+	96.77%	93.75%	3.02%	-1.734	0.011

with recent eye-tracking studies on attentional bias in patients with depression, which detected no significant group differences in the initial attention orientations to sad, happy, and angry faces between patients with depression and healthy individuals (15, 44, 45). The varying results obtained from attentional bias studies conducted in individuals with MDD may be explained by the model of Mogg et al. (46), in which all individuals selectively focus on stimuli that are perceived as dangerous, with differences in attentional responses primarily governed by their subjective evaluations of environmental stimuli, meaning that the threshold for perceiving dangerous stimuli directly affects whether attentional bias is observed. Indeed, individuals who exhibit negative attentional bias tend to have a lower threshold for perceiving stimuli as threatening. However, further research is needed to understand how affective disorders specifically influence such thresholds.

RT for targets on the same side as negative stimuli were significantly longer in the MDD/ADS+ group than in the MDD/ADS- and HC groups. In the point-detection paradigm, there are two explanations for the prolonged reaction time to negative stimuli. The first is that participants have difficulty disengaging their attention from negative stimuli. The second is that participants avoid negative stimuli when initially orienting attention. The first explanation is consistent with the observations of Yiend and Mathews (25): anxiety-related attentional bias are characterized by specific difficulties directing attention away from the location of any threat. In our study, we found that MDD adolescents with anxiety distress have specific difficulties directing attention away

from negative emotional information. The second explanation is consistent with the observations of Price et al. (47): adolescents with anxiety disorder strategically avoid negative or threatening stimuli. MacLeod and Grafton (48) suggested that the mechanism of anxiety may undergo longitudinal changes with age, so attentional bias towards negative or threatening stimuli may be an important factor in the onset and early maintenance of anxiety. However, it may gradually be replaced during disease progression by compensatory or secondary mechanisms, maintaining anxiety and habitual avoidance of negative or threatening stimuli. The vigilance-avoidance hypothesis (49) also proposes that anxiety-related attentional bias changes over time. Initially, individuals maintain vigilance towards negative or threatening stimuli and then subsequently engage in avoidance behaviors. In the current study, MDD adolescents with anxiety distress had significantly lower CRR to negative faces than did those without anxiety distress and HC, suggesting that the MDD/ADS+ group did not use prolonged response times to improve accuracy, but more likely avoided negative/threatening stimuli. Moreover, we observed a positive correlation between RT and HAMA scores in adolescents with MDD, as well as a negative correlation between CRR and HAMA scores, suggesting that with more severe anxiety, avoidance behaviors related to anxiety were increased.

This study had some limitations. First, it was a cross-sectional study, and the cross-sectional studies cannot assess changes in attentional bias over time and are also unable to establish causal attribution. Second, one limitation of this study is the relatively
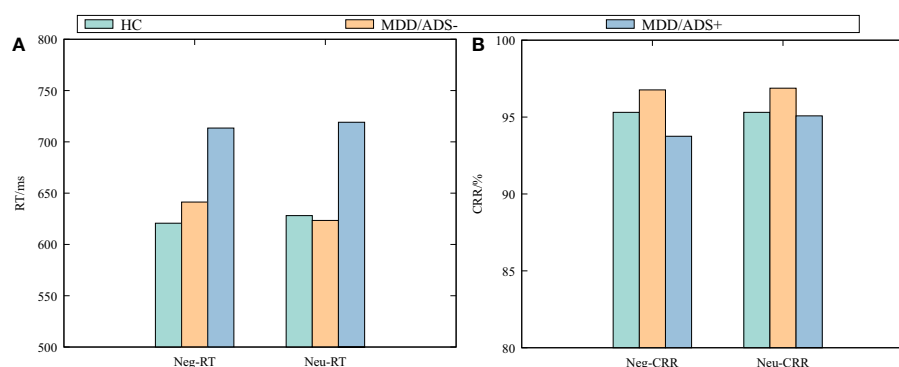

FIGURE 1
Negative and neutral response times (RT) (A) and correct response rates (CRR) (B) by group.

TABLE 4 Wilcoxon signed-rank test for within-group comparisons.

	Neu-RT – Neg-RT	Neu-CRR – Neg-CRR
HC	$Z = -1.159$, $P= 0.246$	$Z = -0.082$, $P= 0.935$
MDD/ADS-	$Z = -1.619$, $P= 0.105$	$Z = -0.289$, $P= 0.773$
MDD/ADS+	$Z = -0.594$, $P= 0.553$	$Z = -1.391$, $P= 0.164$

small sample size. Third, positive emotional faces were not included in our paradigm.

In summary, our study revealed that negative attentional bias is not a stable cognitive trait in adolescents with MDD, and avoidance or difficulty in disengaging attention from negative emotional stimuli may be the attentional bias characteristic of MDD adolescents with anxiety distress. However, the current research cannot differentiate between these two aspects. In future studies, eye-tracking techniques can be employed to validate these findings. In clinical practice, attention bias modification is considered a promising approach for treating depression. Importantly, the effectiveness of attention bias modification relies on understanding the attentional bias specific to different subtypes of depression. Our study identified attentional bias characteristics in adolescents with comorbid anxiety distress, providing guidance for improving attention bias modification protocols in the future, thus achieving more precise and personalized medical interventions.

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 Ethics Committee of the Affiliated Psychological Hospital of Anhui Medical University. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent

was obtained from the minor(s)' legal guardian/next of kin for the publication of any potentially identifiable images or data included in this article.

Author contributions

RY: Conceptualization, Data curation, Methodology, Writing – original draft, Writing – review & editing. HYZ: Project administration, Writing – review & editing. XC: Investigation, Writing – review & editing. DM: Investigation, Writing – review & editing. ML: Data curation, Writing – review & editing. WL: Data curation, Writing – review & editing. HZ: Funding acquisition, Project administration, Writing – review & editing.

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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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Appendix: the shapiro-wilk test results

Table A1 depicts the results of the Shapiro-Wilk test, as is mentioned in Section 2.4.

TABLE A1   The results of the Shapiro-Wilk test.

		W	df	P
Neg RT	HC MDD/ADS- MDD/ADS+	0.916 0.935 0.841	48 47 50	0.002 0.012 0.000
Neu RT	HC MDD/ADS- MDD/ADS+	0.937 0.895 0.833	48 47 50	0.012 0.000 0.000
Neg CRR	HC MDD/ADS- MDD/ADS+	0.864 0.914 0.899	48 47 50	0.000 0.002 0.000
Neu CRR	HC MDD/ADS- MDD/ADS+	0.818 0.845 0.865	48 47 50	0.000 0.000 0.000
AB value	HC MDD/ADS- MDD/ADS+	0.980 0.987 0.821	48 47 50	0.590 0.890 0.000

Impact of social support on the resilience of youth: mediating effects of coping styles

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Background: Chinese youth are at high risk for depression with a significantly higher detection rate of depression risk than other age groups, which brings about a huge challenge to the mental health work of universities. Developing supportive resources that promote resilience against adverse environmental influences in high-risk groups is quite more urgent than medical treatment for firm diagnoses of mental issues that have developed into depression in the current background.

Methods: A total of 665 university students in China completed self-reported questionnaires measuring psychological resilience, social support, and coping styles. The structural equation model testing on the goodness of fit of the theoretical framework was first performed. Descriptive statistics and Pearson's correlation analysis among social support, resilience, and coping styles were then conducted. At last, we tested the mediating role of coping styles.

Results: Social support has a significant positive effect on the psychological resilience of the youth. Mixed coping and immature coping styles have significant negative impacts on both social support and resilience, while mature coping styles have a significant positive effect on social support and resilience. Mature and immature coping styles mediate the association between social support and resilience in youth.

Conclusion: Based on stress theory, this study explores mechanisms that facilitate the development of resilience in young people with regard to social support and coping styles. The current research depicts an interventional perspective of building a social support network that guides the youth to adopt mature coping styles to enhance their resilience and facilitate their mental health.

KEYWORDS

social support, resilience, coping styles, the youth, mental health

1 Introduction

The mental health issues of students in higher education are tending to be a new challenge in public health (1). In 2022–2023, over 40% of students in higher education had clinically significant symptoms of depression in America (2), the trend of which was declared as a mental health crisis by the United States Surgeon General (3). In China, this trouble is equally prominent. According to the survey results of the Report on National Mental Health Development in China (2021–2022), the risk of depression and anxiety among young people is higher than that of other age groups. The detection rate of depression risk in the age group of 18–24 years old was as high as 24.1%, with nearly 50% of them being students (4). Paradoxically, dramatic social changes in recent years have ushered in a great shortage of mental health services (5) while the stigmatization of mental illness discourages people from

seeking help (6–8). In such a background, it is more crucial to provide positive support to enhance the youth's mental resources that help prevent psychological symptoms from developing into mental disorders compared to conventional treatments.

The current study was conducted with a focus on mental health protective factors. We aimed to shed light on the impact of social support on the resilience of youth, taking coping styles as mediating variables to examine the mechanisms of action that individuals apply to cope with stress. The further goal of this study is to offer valuable insights into the evidence and support for the development of psychological service systems for high-risk groups.

1.1 The effect of social support on resilience

Social support and resilience are considered mental health protective factors because they facilitate positive adaptations to adversity and sustain post-trauma growth (9–11). As a positive mental feature, resilience helps individuals counter negative influences of stressors and allows them to cope with adversities or stressful events in a better way, experience fewer negative emotions, and gain a higher level of subjective wellbeing (12–14). Extensive research has confirmed the crucial role resilience has played in promoting mental health and preventing mental illnesses. In the mental health field, resilience was regarded as the protective factor against psychological issues such as loneliness (15) and pressure (16). In studies of students, resilience could effectively predict wellbeing (16, 17) and adjustment to university life (18, 19), leading more and more scholars to advocate intervention strategies that focus on increasing resilience to decrease the risk of mental illnesses (15, 17). According to the conservation of resources theory proposed by Hobfoll, resilience is defined as having abundant mental and social resources in a stressful condition (20), which means resilience helps individuals deploy all their resources to overcome challenging situations. Therefore, high-resilient individuals are better at leveraging various resources to cope with impossibilities and setbacks and could adapt better to stressful conditions (21). Social support, as an essential external resource, plays a fundamental role for individuals to handle stressful environments and incidents in their lives. A multitude of empirical studies have found a positive correlation between resilience and social support. In studies of students, those who perceived more social support reported higher resilience (17), and demonstrated better adaptation to new environments (22). Social support can alleviate the harmful impacts that stressful events have on individuals, and promote resilience to exert a positive influence on psychological wellbeing (23). Thus, we proposed the following hypothesis:

*H*1: Social support positively affects psychological resilience in youth.

1.2 The mediating effects of coping styles

Currently, an increasing number of scholars believe that mental health is the process by which resilience comes into play, with the outcomes determined by the interaction between the features of individuals and their coping styles (24). In coping with stress, individuals tend to adopt different cognitive and behavioral efforts to

manage potential threats and effectively reduce the impact that stress and its adverse consequences have on personal resources (25). Several studies have revealed that adopting suitable coping styles demonstrates a noteworthy positive correlation with a higher level of resilience (19, 23), and accordingly fosters positive outcomes of mental health and psychological wellbeing (26–28). In the existing literature, social support can enhance the resilience of medical staff through positive coping strategies in public health emergencies (29). Similar findings have also been spotted in other clinical research. In Haase's study, social support could significantly affect the resilience of adolescents and young adults with cancer through courageous coping (30). This implies that coping styles could probably play a mediating role in the correlation between social support and resilience. Thus, we proposed the following hypothesis:

*H*2: Coping styles mediate the correlation between social support and resilience.

Figure 1 depicts the theoretical framework for this study.

2 Methods

2.1 Participants and recruitment

This study adopts convenience sampling to conduct a questionnaire-based survey with participants recruited from a university in southern China. The survey was anonymous, and all the participants were made aware of and consented to the objectives of the study before they took the questionnaire. A total of 717 questionnaires were collected with 665 being effective, comprising a response rate of 92.7%.

2.2 Measures

2.2.1 Demographics

We used a demographic questionnaire to collect demographic data, which included five parameters: (a) gender, (b) age, (c) major, and (d) school year.

2.2.2 Measurement of resilience

The Connor-Davidson Resilience Scale (CD-RISC) (31) was adopted to measure resilience. The scale comprises 25 items, each rated on a 5-point Likert scale, with 0 indicating never, 1 seldom, 2 sometimes, 3 often, and 4 almost always. Total scores ranged from 0

FIGURE 1
Theoretical framework.
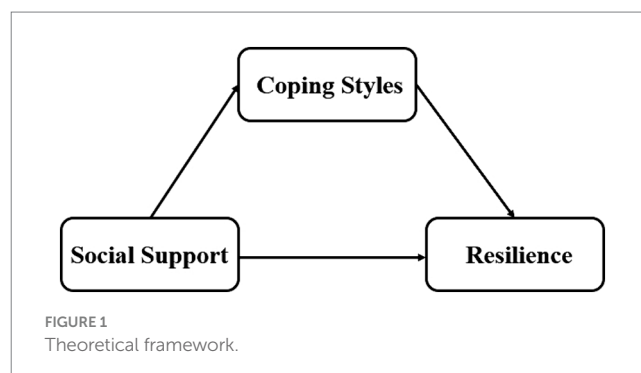
to 100, with higher scores indicating greater resilience. This scale has been tested with solid reliability and validity and has been widely used in both clinical practice and psychological research (29, 32, 33). The internal consistency reliability of this study stood at 0.932.

2.2.3 Measurement of social support

The Social Support Rating Scale developed by Shuiyuan (34), which presented sound psychometric properties in the Chinese population (35), was adopted to measure social support. It consists of 10 items with three dimensions: subjective social support, objective social support, and utilization of social support. Subjective social support refers to personal emotional experience and satisfaction about the respect, support, and understanding that an individual gains. It consists of four items [e.g., How many close friends do you have, and from whom you can gain support and help? (1) None, (2) 1–2, (3) 3–5, and (4) 6 and above]. Objective social support refers to specific or valuable assistance, including direct material support, community relationships, and group participation. It comprises three items (e.g., Over the past year, you have been (1) staying away from your family and living alone; (2) traveling too much and spending most of your time with strangers; (3) living with friends from school, work, or other places; and (4) living with your family). Utilization of social support refers to an individual's positive usage of various forms of social support, including ways of communication and seeking help as well as participating in events. It consists of three items (e.g., What do you do when you are bothered about something? (1) You never tell anybody about your troubles; (2) You only share your troubles with one or two close friends; (3) You tell your friends if they ask; and (4) You openly communicate your troubles to gain support and understanding). The total scores on the scale ranged from 12 to 66, with higher scores indicating a higher level of social support. The internal consistency reliability for the three dimensions mentioned above stood at 0.646, 0.597, and 0.575, respectively.

2.2.4 Measurement of coping styles

The Coping Styles Questionnaire (CSQ) (36), which was developed according to Folkman and Bond's coping and defense questionnaires (37, 38), was adopted to examine the coping styles of the youth. This questionnaire has been primarily used to assess coping in the context of Chinese language features with solid reliability and validity (26, 39). The questionnaire consists of subscales (problem-solving, self-blame, help-seeking, fantasizing, avoidance, and rationalization) and 62 items, each rated 0 (agree) or 1 (disagree). Among the six subscales, problem-solving and help-seeking were considered mature coping styles; avoidance, fantasizing, and self-blame were regarded as immature coping styles; and rationalization was considered as the mixed coping style. In this study, the internal consistency reliability of the six sub-scales ranged from 0.776 to 0.899.

3 Data analysis

Analysis of the data was conducted utilizing IBM SPSS 23.0 and AMOS 24.0. The structural equation model testing on the goodness of fit of the theoretical framework was first conducted through AMOS 24.0. Then we performed the Harmon single-factor test to detect the common method bias (40). Descriptive statistics and Pearson's correlation analysis among social support, resilience, and coping styles was conducted through IBM SPSS 23.0. The mediating role of coping style was tested through the SPSS macro program PROCESS 3.5 developed by Hayes (Model 4) (41).

4 Results

4.1 Testing of the goodness of fit of the theoretical framework

The hypothesized relationships of the study's framework were tested in the structural model through AMOS 24.0, the results of which have been depicted in Table 1. The results indicate a good fit of the theoretical model with $\chi^2/\mathrm{df} = 2.507$, SRMR = 0.050, RMSEA = 0.048, GFI = 0.901, AGFI = 0.886, IFI = 0.922, CFI = 0.921, TLI = 0.915. Therefore, the hypothesized framework was a good fit for the empirical data (42).

4.2 Control and testing for common method bias

As all questionnaires used in this study were self-rating scales, there may have been common method bias. To detect this, we adopted the Harmon single-factor test. The results showed a total of 21 factors with eigenvalues greater than one and 19.81% of the variances being explained by the first factor, which were less than the critical standard of 40%. This indicated that there was no significant common method bias in this study (40).

4.3 Descriptive statistics and correlation analysis

Table 2 depicts the descriptive statistics. More than half of the participants were female (64.66% of the total), with an average age of 20.36 ± 1.81 years old. In terms of major, most of the participants majored in social sciences (88.57%).

Table 3 displays the results of the correlation analysis. The analysis shows that social support had a significant positive correlation with resilience ($p < 0.01$), indicating that social support was an essential fortifying factor for resilience and might thus promote resilience against adversities and stressful circumstances.

TABLE 1 The main indicators of the model fit test ($N = 665$).

Fit indices	χ^2/df	SRMR	RMSEA	GFI	AGFI	IFI	CFI	TLI
Reference values	<3	<0.08	<0.08	>0.90	>0.90	>0.90	>0.90	>0.90
Goodness-of-fit	2.507	0.050	0.048	0.901	0.886	0.922	0.921	0.915

Hypothesis 1 was supported. Mixed and immature coping styles had a significant negative correlation with resilience ($p < 0.01$), while mature coping styles demonstrated significant positive correlations with resilience ($p < 0.01$). Mixed and immature coping styles displayed significant negative correlations with social support ($p < 0.01$), while mature coping styles showed significant positive correlations with social support ($p < 0.01$). The results of correlation analysis indicate that different coping styles have different effects on resilience. Compared with mixed and immature coping styles, mature coping styles can effectively enhance individuals' resilience.

4.4 Test for the mediating effects of coping styles

To test the mediating effect that coping styles play in the relationship between social support and resilience, we conducted a bootstrapping analysis with 5,000 resamples (41, 43). See Table 4 for detailed results. The analysis showed that social support had a significant positive impact on mature coping styles ($\beta = 0.386$, $p < 0.01$) and a negative effect on the mixed coping style ($\beta = -0.258$, $p < 0.01$) and immature coping styles ($\beta = -0.315$, $p < 0.01$). Meanwhile, the impact that social support had on resilience is also statistically significant ($\beta = 0.301$, $p < 0.01$). The mediating role of coping style was tested through the SPSS macro program PROCESS 3.5, the results of which indicated a significant positive impact mature coping styles having on resilience ($\beta = 0.175$, $p < 0.01$) while a negative effect with the immature coping style ($\beta = -0.259$, $p < 0.01$). Accordingly, the relationship between social support and resilience was mediated by coping styles (mature and immature coping styles), indicating that coping

TABLE 2 Descriptive statistics of the participants ($N = 665$).

Variable	N	Percent (%)/ Mean $\pm$ SD
Gender		
Male	235	35.34%
Female	430	64.66%
Age		20.36 $\pm$ 1.81
Major		
Social work	243	36.54%
Accounting	178	26.77%
Finance	168	25.26%
Other majors	76	11.43%
School year		
Freshman	267	40.15%
Sophomore	162	24.36%
Junior	142	21.35%
Senior	94	14.14%

TABLE 3 Correlation analysis of major factors ($N = 665$).

Variables	M	SD	1	2	3	4	5
1. Resilience	77.408	14.586	–				
2. Mixed coping style	4.382	2.439	−0.253**	–			
3. Mature coping styles	17.808	2.585	0.325**	−0.058	–		
4. Immature coping styles	10.651	7.463	−0.331**	0.856**	−0.142**	–	
5. Social support	42.414	6.610	0.435**	−0.258**	0.386**	−0.315**	–

**$p < 0.01$.

TABLE 4 Bootstrapping analysis of the mediating effect of coping styles.

Process	Variable	Model 4					
		R^2	F	β	SE	t	95% CI
1. Mediator variable model (CS)							
MICS		0.066	47.119	−0.258	0.014	−6.864**	[−0.122, −0.068]
MCS	SS	0.149	116.020	0.386	0.014	10.771**	[0.123, 0.178]
IMCS		0.099	73.211	−0.315	0.042	−8.556**	[−0.438, −0.274]
2. Dependent variable model (RIS)	SS			0.301	0.084	7.929**	[0.499, 0.827]
	MICS			0.056	0.390	0.857	[−0.432, 1.101]
	MCS			0.175	0.207	4.790**	[0.584, 1.395]
	IMCS			−0.259	0.130	−3.897**	[−0.761, −0.251]
$R^2 = 0.259$, $F = 57.718$							

CS, coping style; RIS, resilience; SS, social support; MICS, mixed coping style; MCS, mature coping styles; IMCS, immature coping styles; CI, confidence interval. **$p < 0.01$.

styles were the mechanism by which the effect of social support had on resilience. These results supported Hypothesis 2.

5 Discussion and conclusion

Youth populations are facing unprecedented mental health challenges (1–4). Compared to conventional medical treatments, it is more crucial to provide positive support to enhance the youth's mental resources that help prevent psychological symptoms from developing into mental disorders. Resilience, social support, and coping styles have important implications for mental health. The current study explored the interrelationships among resilience and internal (coping styles) and external (social support) resources, trying to find an interventional mechanism of how the protective factors operate. The research findings showed that social support and coping styles had significant correlations with resilience, and the hypothesized framework manifested a good fit. Resilience of the youth can be positively predicted by social support and mature coping styles, while negatively predicted by mixed and immature coping styles. Our findings are consistent with studies that have verified the significant effects these factors exert in buffering adverse outcomes in different populations (13, 14, 23, 29), which confirms the protective functions of social support and mature coping styles to psychological wellbeing.

Our study has also developed a theoretical framework in which coping styles were considered as the mediating mechanisms that act on resilience through social support. We found that mature coping styles (problem-solving and help-seeking) were significantly and positively related to social support and resilience while immature coping styles (avoidance, fantasizing, and self-blame) showed a significant effect otherwise. Consistent with previous research, mature coping styles often promote higher resilience and good adaptation in stressful situations (15, 17, 19). However, the mediating effect of coping styles showed inconsistency in studies of varied populations. In our study, the mediating effects of both mature and immature coping styles were significant, with an insignificant mediating effect of the mixed coping style. In adolescents with hemophilia, the mediating effect of positive coping barely influenced the relationship between social support and resilience (28). In adult population, however, positive coping played a significant role in mediating social support and resilience-related features (44, 45). The inconsistency may result from the possibility that the coping styles of different populations are influenced by personal traits and diverse cultural environments (24, 39, 46). In studies of military groups, negative coping styles were commonly used because of the advocated culture that urged military personnel to operate proficiently in stressful environments (47).

The current research focused on the protective factors of mental health. We carried out an initial exploration into the relationships among social support, coping styles, and resilience in the youth, trying to find an interventional mechanism of how the protective factors operate. Our findings indicated that mental health interventions, which aim to help the youth develop resilience, should encourage individuals to adopt mature coping styles, such as seeking help and avoiding the use of immature coping styles, such as self-blame and avoidance, in stressful situations. In this way, the youth can promote psychological wellbeing in a more effective way.

However, this study has limitations. Firstly, some of our findings are inconsistent with previous research. Several studies have revealed that demographics such as gender and major would influence individuals' coping mechanisms and resilience (17, 19). Therefore, identifying key demographic variables that affect the protective factors of mental health may be of great benefit for accurate intervention in preventing mental illness. Secondly, this study found that the mixed coping styles (rationalization) had a significant positive correlation with immature coping styles, which is inconsistent with findings that the mixed coping styles demonstrated a significant negative correlation with mature coping styles (48). It probably indicated that when coping with a stressful situation, as a mixed coping style, rationalization may operate through different mechanisms and thus exert separated influences. It is necessary to further discuss if there are prioritized coping strategies in different groups in future research. Lastly, considering the limitations of cross-sectional studies, future studies should leverage longitudinal research and experiments to confirm the interrelationships of the protective factors and provide more convincing evidence and more reliable guidance for the implementation of psychological services in practice.

Data availability statement

The datasets presented in this article are not readily available because of participant privacy and ethical requirements. Requests to access the datasets should be directed to caofei@jiangnan.edu.cn.

Ethics statement

The studies involving humans were approved by the Ethics Committee of Jiangnan University. 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

FC: Writing – original draft. JL: Supervision, Writing – review & editing. WX: Formal Analysis, Writing – original draft. NC: Investigation, Writing – original draft.

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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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