

Internet use and psychological well-being among children and adolescents

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Internet use and psychological well-being among children and adolescents

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Editorial: Internet use and psychological well-being among children and adolescents

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KEYWORDS

social media use, internet use, smartphone use, problematic internet use, children and adolescents

Editorial on the Research Topic

Internet use and psychological well-being among children and adolescents

Introduction

Internet use (e.g., smartphone use, social media use) is almost indispensable in our daily lives and it plays an increasingly important role in shaping human wellbeing. Contemporary adolescents spend a significant amount of time on technological devices such as smartphones especially during COVID-19. As there is a strong need to understand the relationship between problematic Internet use [i.e., the incapacity to regulate one's Internet use, (1)] and psychological wellbeing of children and adolescents as well as the determinants of problematic Internet use, we launched this Research Topic project examining the association between problematic Internet use and psychological as well as behavioral outcomes. We also examined the related risk and protective factors in problematic Internet use.

There are several unique features of this Research Topic. First, this Research Topic investigates problematic Internet use among children and adolescents in different parts of the globe, including mainland China, Hong Kong, South Korea, Saudi Arabia, and Chile. This is important because existing studies in this field are dominated by “WEIRD” studies, with data collected predominantly from Western, educated, industrialized, rich, and democratic societies. The Research Topic comprises nine papers, with contribution from 43 investigators from mainland China, Hong Kong, South Korea, Saudi Arabia, UK, US, and Chile. Second, in response to the methodological issues highlighted by Shek (2), researchers in these studies employed a wide range of research designs including cross-sectional, longitudinal, experimental, and meta-analytic studies as well as secondary analyses of national data sets, with data collected before and after the COVID-19 pandemic. Third, this Research Topic highlights the risk and protective factors for problematic Internet use, such as coping and cyberbullying.

Problematic Internet use and developmental outcomes

The studies in this Research Topic showed that there was a positive relationship between problematic Internet use and psychological and behavioral outcomes among children and adolescents, such as an increase in depressive and anxiety symptoms, physical and psychosocial symptoms, runaway behavior and aggression but a decrease in physical activity and life satisfaction.

Zhao et al. employed a longitudinal study to examine the association between Internet addiction and depressive and anxiety symptoms among Chinese adolescents. Chinese adolescents ($N = 7,958$) completed two-wave surveys before and during the COVID-19 pandemic (six-month interval). Results showed that psychological problems and Internet addiction significantly influenced each other.

Tsang et al. investigated the associations between electronic device use and the prevalence and severity of musculoskeletal symptoms, visual symptoms, psychosocial health, and quality of life in 1,058 primary and secondary school students in Hong Kong. Results revealed that excessive electronic device use was associated with increased prevalence and severity of physical and psychosocial symptoms, and such use was more prevalent in adolescents as compared to young children.

To examine the factors influencing adolescents' runaway behavior, Kim and Moon employed the national data of 11,354 adolescents from the Survey of Media Usage and Harmful Environment among adolescents in South Korea. They reported that exposure to harmful social media (e.g., adult online games, gambling games involving betting money or cyber money, messengers or chat apps for conditional dating) was an important antecedent of adolescent runaway behavior.

Al-Amri et al. used experimental and survey methods to examine the effects of smartphone addiction on the cognitive function and physical activity in middle-school children ($N = 196$) recruited from middle schools in Saudi Arabia. Results showed some odd findings. While smartphone addiction was associated with a lower level of physical activity, it was related to better (i.e., not poorer) cognitive functioning.

Varela et al. investigated the moderating effect of various coping mechanisms on the association between social media addiction and adolescent life satisfaction during the COVID-19 pandemic period. Participants were 1,290 secondary school students in Chile. Results indicated that social media addiction and use of maladaptive stress coping strategies were risk factors associated with decreased life satisfaction among Chilean adolescents.

Li et al. conducted a meta-analytic study to examine the relationship between Internet gaming disorder and aggression among teenagers and young adults. They found that there was a significant relationship between Internet gaming disorder and aggression.

The studies in this Research Topic also identified some risk and protective factors for problematic Internet use. Risk factors included exposure to domestic violence, parental psychological control, childhood trauma, and online social anxiety. Besides, we identified several protective factors, including positive

social control and self-control, parental behavioral control, positive parent-child relationships, and emotional intelligence as protective factors.

For example, Quancai et al. investigated the role of social control and self-control in the association between exposure to domestic violence and adolescent Internet gaming addiction. Participants were 2,110 adolescents recruited from Liangshan Yi Autonomous Prefecture in Sichuan Province, China. Results suggest that adolescent exposure to domestic violence increases adolescents' addiction to Internet games, and indirectly influences it through decreasing adolescents' social control and self-control.

Zhu et al. also investigated whether parent-child relationship moderated the association between parental control and adolescent Internet addiction. They recruited 1,974 Chinese adolescents in Guizhou Province in mainland China. Results indicated the positive impact of parental behavioral control and the negative impact of psychological control on the development of adolescent Internet addiction. Furthermore, positive father-adolescent relationship strengthened the positive effect of paternal behavioral control and mitigated the negative effect of psychological control of both parents on Internet addiction.

Furthermore, Cao et al. investigated the association between childhood trauma and adolescent cyberbullying perpetration as well as the mediating role of emotional intelligence and online social anxiety. Based on the responses of 1,046 adolescents from four schools in Shandong Province, China, results showed that childhood trauma was positively associated with adolescent cyberbullying perpetration. Moreover, emotional intelligence and online social anxiety mediated the association between childhood trauma and cyberbullying perpetration.

There are several significant contributions of this Research Topic. First, in view of the lack of systematic studies in this area in Chinese adolescents, this is a constructive contribution to the literature (3). Second, the Research Topic provides support for the social ecological model on adolescent development [e.g., (4)]. In particular, the studies in this Research Topic highlight the importance of personal as well as family ecological factors. Third, in response to the methodological issues highlighted by Shek (2), the studies in this study adopted different research designs with the recruitment of large samples. Finally, the present findings can help design effective intervention programs to reduce problematic Internet use and mental health problems in children and adolescents. Consistent with previous studies (5–7), the studies in this Research Topic highlight the importance of promoting emotional intelligence and self-control as well as parenting qualities to reduce problematic Internet use in children and adolescents.

Author contributions

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The authors declare that the research was conducted in the absence of any commercial or financial relationships

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The longitudinal association between internet addiction and depressive and anxiety symptoms among Chinese adolescents before and during the COVID-19 pandemic

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Background: The COVID-19 pandemic and related prevention policies, such as home quarantine or online courses, could increase the risks of experiencing internet addiction and mental health problems among Chinese adolescents. There is a lack of longitudinal evidence to show the association between internet addiction symptoms and psychological consequences (e.g., depressive and anxiety symptoms).

Objective: This study aimed to explore the association between internet addiction and depressive and anxiety symptoms before and during the coronavirus disease 2019 (COVID-19) pandemic.

Methods: An effective sample of 7,958 Chinese adolescents was recruited for this two-wave longitudinal survey conducted over a six-month interval. All participants completed two-wave surveys before and during the COVID-19 pandemic. A longitudinal cross-lagged path model was used to analyze the associations between internet addiction and depressive and anxiety symptoms after controlling for four covariates (i.e., age, sex, minority, and COVID-19 influence).

Results: Higher depressive and anxiety symptoms before COVID-19 significantly predicted severe internet addiction during COVID-19. Results showed a significant bidirectional relationship between internet addiction and depressive symptoms. Furthermore, the prevalence of internet addiction displayed an increasing trend over the two waves. Conversely, a reduced prevalence of anxiety and depressive symptoms was observed over the two waves.

Conclusion: This current study provided valuable evidence that psychological problems and internet addiction significantly influenced each other before and during the COVID-19 outbreak. Consequently, the presence of psychological problems before and during the COVID-19 outbreak could indicate internet addiction. Thus, depression- and anxiety-related psychotherapies should be developed to prevent internet addiction among Chinese adolescents.

KEYWORDS

internet addiction, depressive, anxiety, adolescents, COVID-19

Introduction

Several coronavirus disease 2019 (COVID-19) prevention and control measures could lead to prolonged internet exposure and exacerbate internet-related addictive behaviors and symptoms among Chinese adolescents (1). Globally, the COVID-19 outbreak resulted in multiple pressure events, including interpersonal relationships, financial difficulty, unemployment, and quarantine policy. Consequently, these events can widely impact the psychological, social, and physical wellbeing of individuals (2). To stem further transmission of COVID-19, a comprehensive lockdown policy was implemented early in 2020 across severely affected cities in mainland China, such as Wuhan, Chengdu, and Shanghai. Furthermore, the Ministry of Education imposed school closures to reduce social interaction and large-scale congregation. All students across the lockdown-implemented cities were required to stay home, maintain social distancing, undergo nucleic acid daily testing, and learn online (3). Therefore, students at home experienced increased exposure to the internet and spent more time engaging daily in online activities (i.e., socializing, chatting, and leisure activities) during the COVID-19 pandemic than before. Consequently, this could increase their risk of suffering from internet addiction symptoms (4).

Internet addiction refers to the excessive, compulsive, or poorly controlled behaviors related to spending plenty of time on internet use that results in psychiatric impairment, dysfunction, and distress (5). Recent research indicated an upsurge in the prevalence of problematic internet use from 14.4% before COVID-19 to 52% during the pandemic (6). Moreover, the latest systematic review analyzed 11 related studies and revealed that during COVID-19 there was an increased dependence on internet use (46.8%) and a low to mild degree of internet addiction was very common (62%) (5). Furthermore, several prior studies with small samplings reported that adolescents were vulnerable to suffering from internet addiction symptoms, and the prevalence of addictive internet use ranged from 24.4 to 55% among Chinese adolescents during COVID-19 (1, 3, 7). Additionally, previous researchers have reported on the exaggerated prevalence of depression (8, 9) and anxiety (10, 11) among the Chinese population during the COVID-19 pandemic. The multiple pathways model effectively supported the close and frequent relationship between depressive and anxiety symptoms in youth (12). The previous review evidenced the interplay between depressive and anxiety symptoms among adolescents (12). However, large-sampling evidence investigating the developing trend in internet addiction, depressive, and anxiety symptoms among Chinese adolescents across the COVID-19 stages (e.g., before and during the COVID-19 outbreak) remains limited. Thus, the following hypotheses were formulated based on prior literature:

- H1: Internet addiction among adolescents increased from before COVID-19 to during COVID-19.
- H2: Depressive symptoms among adolescents worsened from before COVID-19 to during COVID-19.
- H3: Deteriorated anxiety symptoms among adolescents is present from before COVID-19 to during COVID-19.

Many studies have found a significant association between internet addiction and psychological problems among adolescents during COVID-19 (1, 13, 14). Furthermore, a previous study with

a sample of 561 adults in Mexico found that internet addiction was significantly associated with depression and anxiety (15). Similarly, Servidio et al. (16) confirmed the significant and positive association between anxiety and internet addiction during the first national COVID-19 lockdown based on a sample of 454 Italian students. A large-scale survey also proved that internet addiction positively correlated with depression among 4,734 Indonesian adults (6). Moreover, previous studies indicated a high rate of co-occurrence between internet addiction and mental health disorders (9, 17). In addition, the previous study emphasized the hazardous consequences underlying the comorbidity of internet addiction and psychological problems, namely, worse prognosis, severe damage to social function, and higher interference with everyday life (17). Furthermore, a few studies indicated that individuals who were younger (15), female (18), and minorities (19), were more impacted by COVID-19 (16) and associated with internet addiction, anxiety, and depressive symptoms. However, most studies exploring this issue only focused on the adult population using a cross-sectional survey design (6, 15, 16). To date, large-sample longitudinal evidence exhibiting the association between internet addiction and psychological problems among large-sample Chinese adolescents remains limited.

Some theories provide conceptual elucidations underscoring the links between internet addiction and mental health problems. For example, the Problem-Behavior Theory proposed by De Leo and Wulfert (20) showed a synthetic theoretic framework illustrating individuals who lack a social network and exhibit worse psychologically internalizing problems (e.g., issues with social anxiety and depression) were more susceptible to problematic Internet use (21). Furthermore, the Interaction of the Person-Affect-Cognition-Execution (I-PACE) model presented the interpretation mechanisms for internet addiction development (22, 23). This model proposed four key variables, namely, personal characteristics, emotional replies for internal or external incentives, executive and repressive control, and resolution-making behavior. Consequently, these variables led to internet-related problematic usage (23). Based on the I-PACE, when people with psychological problems experienced internet usage-related signals, they could be affected by deteriorating negative emotions, possibly resulting in reduced executive and repressive control (22). Therefore, individuals could be seeking mood-dismissing approaches to evade real life and tend to engage in internet-related activities. Conversely, individuals gain happiness from virtual satisfaction and recompense real life experiences through internet usage (24). These theoretical frameworks have been empirically supported for investigating internet addiction and psychological problems (24, 25). Based on previous literature, the following hypotheses were proposed:

- H4: Internet addiction before COVID-19 significantly and positively predicts depressive symptoms during COVID-19.
- H5: Internet addiction before COVID-19 significantly and positively predicts anxiety symptoms during COVID-19.
- H6: Depressive symptoms before COVID-19 significantly and positively predict internet addiction during COVID-19.
- H7: Anxiety symptoms before COVID-19 significantly and positively predict internet addiction during COVID-19.

This current study comprised two-wave longitudinal data and utilized the cross-lagged modeling analysis to explore the associations between internet addiction and mental health problems (e.g.,

depressive and anxiety symptoms) among Chinese adolescents before and during the COVID-19 pandemic. The controlled covariates in this study included age, sex, minority, and COVID-19 influence in the modeling analysis. Furthermore, the prevalence changes in internet addiction, depression, and anxiety symptoms before and during the stages of COVID-19 were examined in this study.

Methods

Data collection

The dataset of the current study is derived from the Chengdu Positive Child Development (CPCD) research project (26). The participants were recruited from five primary or middle schools in Chengdu using the simple random sampling approach. The self-report questionnaire was used to collect data before and during COVID-19 in China. Two-wave studies have been completed with six-month time intervals, namely Wave 1 (W1, December 23, 2019, to January 13, 2020, before COVID-19) and Wave 2 (W2, June 16 to July 8, 2020, during COVID-19). Questionnaires were distributed to 10,370 potential participants, and 8,749 valid responses were returned in the W1 study (valid reply rate = 84.37%, 48.38% women). A total of 7,958 participants were followed in the W2 study (valid reply rate = 76.74%). However, there were 791 participants who were lost to be followed in the W2 study. The study was approved by the Research Ethics Committee of the research university and the schools' administrations where participants were recruited (approval number: K2020025). All participants and their guardians were informed of the research objective, procedure, privacy, risk, and data retention before providing their signed informed consent.

Measures

Internet addiction

The current study used the Chinese version of the Young Internet Addiction Test (YIAT), which assesses the severity of internet addiction through the 20-item self-report measure (27). Participants were guided to rate each item on a five-point Likert scale ranging from 1 to 5 (1 = rarely and 5 = always). For example, a sample item assessed, "How often do you find that you stay online longer than you intended?" Thereafter, the scores of all items were calculated which displayed the degree of internet addiction symptoms. A higher score denoted severe internet addiction. Based on the recommended diagnostic standards (27), total scores exceeding 31 indicated an abnormal level of Internet use. Furthermore, YIAT showed significant reliability and validity in previous research (27). Similarly, the reliabilities of this scale were excellent in both W1 (Cronbach's alpha = 0.93) and W2 (Cronbach's alpha = 0.94) surveys. The construct validities of this scale were good in both W1 (Kaiser-Meyer-Olkin [KMO] measure of sampling adequacy = 0.87) and W2 (KMO measure of sampling adequacy = 0.87) surveys.

Anxiety symptom

The Chinese version of the Screen for Child Anxiety Related Emotional Disorders (SCARED) subscale assessed the anxiety

symptom for the last 3 months (28). A three-point Likert scale was used in the nine-item subscale, rating from 0 = never to 2 = often. One sample item is "people tell me that I worry too much." Adding the scores of all items denoted the severity of anxiety symptoms. A higher score represented a more serious anxiety symptom. The cut-off score was recommended as 9 for diagnosing anxiety disorders among adolescents (28). Previous studies evidenced the great validity and reliability of SCARED that applied in this current study (28). The reliabilities of this scale were good in the W1 (Cronbach's alpha = 0.86) and W2 (Cronbach's alpha = 0.88) surveys. This scale showed the excellent construct validities in both W1 (KMO measure of sampling adequacy = 0.92) and W2 (KMO measure of sampling adequacy = 0.93) surveys.

Depressive symptom

The Chinese Version of the Center for Epidemiologic Studies Depression Scale (CES-D) consists of 20 items that evaluated the degree of depressive symptoms during the past week (29). A four-point Likert scale was used to rate each item (0 = not at all, 3 = often). Furthermore, there were four reversed score items, namely, the fourth, eighth, twelfth, and sixth items. A sample item states, "I experienced difficulty with focusing my mind on what I was doing." Similarly, this scoring method followed the previously suggested rules that summed the scores of all items. Consequently, higher scores represented worse depressive symptoms (29). Moreover, total scores that were higher than 15 represented a depression diagnosis. Previous research found that the CES-D exhibited great reliability and validity (29). In the current study, the CES-D showed decent reliabilities in both W1 (Cronbach's alpha = 0.87) and W2 (Cronbach's alpha = 0.89) surveys. The construct validities of this scale were excellent in both W1 (KMO measure of sampling adequacy = 0.94) and W2 (KMO measure of sampling adequacy = 0.95) surveys.

Covariates

The covariates were informed by the demographics (i.e., age, sex, and minority) and COVID-19 influence. The current study defined COVID-19 influence as the perceived degree of personal influence resulting from COVID-19 in terms of daily life and social activities. Based on the COVID-19 pandemic context, nine items were designed to assess the COVID-19 influence on sampling participants (30). COVID-19 influence was evaluated in three ways. First, four items assessed perceived seriousness, threat, contagion danger, and precaution against COVID-19 using a four-point Likert scale (1 = not at all, 4 = extremely severe). Second, one dichotomous question asked whether the COVID-19 case was confirmed in participants or their families (1 = no, 2 = yes). Finally, four questions investigated the perceived effect of COVID-19 on diet, daily study, interpersonal relationships, and leisure activities ranging from 1 to 4 (1 = none to 4 = extremely influenced). The level of COVID-19 influencing participants was determined by summing the scores of all items. Consequently, a higher score represented a more severe perceived influence of COVID-19.

Statistical analysis

The data analysis contained fivefold processes and was applied using computer software, AMOS Version 23 and SPSS version 24 (31). First, descriptive analysis was used to explore the participants' features based on the study variables (i.e., age, sex, minority, COVID-19 influence, internet addiction, depressive, and anxiety symptoms). Second, the Independent-Samples t-tests and Pearson's chi-squared tests were applied to analyze the significant differences between study variables across study waves. Third, a correlation matrix was used to test the significant links between study variables in the condition of controlling and without controlling covariates. Fourth, an invariance measurement test was used to assess the stability of study variables in a longitudinal cross-lagged model. The multi-collinearity test evaluated the risk of collinearity issues among study variables. Finally, a longitudinal cross-lagged model was constructed and examined using structural equation modeling. Consequently, three significant levels were used in this current study, including $p < 0.05$, $p < 0.01$, and $p < 0.001$ (32).

Results

Participant characteristics

The final sampling participants consisted of 7,958 Chinese adolescents who completed the two-wave surveys. The study comprised 4,112 men (51.7%) and 3,846 (48.3%) women, with a mean age of 12 years old (standard deviation [SD] = 2.15, age ranging from 7 to 17). Most participants belong to the Han ethnic group ($n = 7,893$, 99.18%). The current study did not find any significant differences between valid samples and missing track samples in all study variables ($ps > 0.05$), apart from internet addiction, anxiety, depressive symptoms, and age. Furthermore, older participants with more severe internet addiction, higher anxiety, and more serious depressive symptoms were more likely to drop out of the follow-up survey (Table 1).

Inter-correlations analysis

Table 2 depicts the means, inter-correlation, and the SD results among the study variables. According to recommended criteria for the correlation degree (33), the absolute coefficients value between 0.50 and 1 represent a high level of correlation, while the values 0.30 and 0.49 represent a moderate level of correlation, and the values below 0.29 indicate a low level of correlation. When controlling for the four covariates of age, sex, minority, and COVID-19 influence, most variables presented high or moderate correlated links with each other, except W1 internet addiction with W2 depressive ($r = 0.27$, $p < 0.001$) and W2 anxiety symptoms ($r = 0.24$, $p < 0.001$). Relatively low degrees of correlation between the remaining study variables were shown. Likewise, upon removing the controlled four covariates, the correlations of W1 internet addiction with W2 depressive ($r = 0.29$, $p < 0.001$) and W2 anxiety symptoms ($r = 0.27$, $p < 0.001$) remained at a significantly and relatively low level. Moreover, internet addiction displayed significant and positively longitudinal correlations with depressive and anxiety symptoms across the study waves.

TABLE 1 Participants' characteristics ($n = 7,958$).

Variables	(M, SD, N, %)
Age (7–17)***	M = 12, SD = 2.15
Sex	
Men	4,112 (51.7%)
Women	3,846 (48.3%)
Minority	
Hans	7,893 (99.2%)
Non-Hans	65 (0.8%)
COVID-19 influence	M = 21, SD = 4.05
Internet addiction***	
Wave 1	M = 34.66, SD = 14.76
	N _{Yes} = 3,931 (49.40%)
	N _{No} = 4,027 (50.60%)
Wave 2	M = 35.06, SD = 15.13
	N _{Yes} = 4,016 (50.46%)
	N _{No} = 3,942 (49.54%)
Depressive symptom	
Wave 1	M = 14.40, SD = 10.16
	N _{Yes} = 3,078 (38.68%)
	N _{No} = 4,880 (61.32%)
Wave 2	M = 14.36, SD = 10.62
	N _{Yes} = 2,924 (36.74%)
	N _{No} = 5,034 (63.26%)
Anxiety symptom***	
Wave 1	M = 3.71, SD = 3.96
	N _{Yes} = 1,036 (13.02%)
	N _{No} = 6,922 (86.98%)
Wave 2	M = 3.33, SD = 4.07
	N _{Yes} = 1,016 (12.77%)
	N _{No} = 6,942 (87.23%)

(1) SD, Standard Deviation; M, Mean; N_{Yes}, number of participants with Internet addiction, anxiety or depressive symptoms; N_{No}, number of participants without Internet addiction, anxiety or depressive symptoms; (2) Diagnostic cut-off scores: Internet addiction ≥ 31 , depressive symptom ≥ 15 , anxiety symptom ≥ 9 ; (3) *** $p < 0.001$ (chi-square tests or t-tests across wave data).

Invariance measurement

Based on the previous recommendations, stability coefficients were selected to evaluate the invariance measurement of study variables across waves (34). When the stability coefficients were higher than 0.4, the invariance measurement was statistically supported in the longitudinal cross-lagged model. Consequently, this study found that stability coefficients of internet addiction as well as anxiety and depressive symptoms at both waves were 0.62, 0.59, and 0.50, respectively. Thus, this result supported the invariance measurement in the longitudinal cross-lagged path model.

TABLE 2 Inter-correlations between Internet addiction, depressive and anxiety symptoms ($n = 7,958$).

#	Variables	1	2	3	4	5	6
1	W1 anxiety symptom	/	0.49***	0.61***	0.41***	0.38***	0.31***
2	W2 anxiety symptom	0.52***	/	0.40***	0.62***	0.24***	0.38***
3	W1 depressive symptom	0.61***	0.41***	/	0.52***	0.40***	0.33***
4	W2 depressive symptom	0.43***	0.64***	0.53***	/	0.27***	0.41***
5	W1 internet addiction	0.39***	0.27***	0.38***	0.29***	/	0.50***
6	W2 internet addiction	0.33***	0.41***	0.32***	0.43***	0.57***	/

(1) The number in lower left is the correlation coefficient without controlling for the four covariates (i.e., age, sex, minority, and COVID-19 influence). The number in top right is the correlation coefficient after controlling four covariates. (2) *** $p < 0.001$. (3) Correlation coefficients interval: High level: between ± 0.50 and ± 1 ; Moderate level: between ± 0.30 and ± 0.49 ; Low level: below ± 0.29 .

Multi-collinearity test

As suggested by previous research, a multi-collinearity issue could occur when the values of variance inflation factor (VIF) and Tolerance were higher than 4.0 and lower than 0.25, respectively. Furthermore, the results of multi-collinearity test displayed that internet addiction (VIF = 1.23, Tolerance = 0.82), depressive (VIF = 1.65, Tolerance = 0.61), and anxiety (VIF = 1.66, Tolerance = 0.60) symptoms did not lie in the boundaries. Consequently, a very low risk of multi-collinearity was found in the current study.

Prevalence of internet addiction, depressive and anxiety symptoms

Table 1 displays the prevalence of internet addiction, depressive, and anxiety symptoms in both study waves. First, the prevalence of internet addiction increased from 49.40% in W1 to 50.60% in W2. Conversely, the prevalence of anxiety symptoms decreased from 13.02% at W1 to 12.77% at W2. Similarly, the prevalence of depressive symptoms declined from 38.68% at W1 to 36.74% at W2. Furthermore, the results of the paired-sample t -test yielded significant differences in the mean level of internet addiction and anxiety symptoms across study waves ($ps < 0.001$). These results supported H1 but rejected H2 and H3.

Cross-lagged path model

Based on previous research (35), a variety of goodness-of-fit indices were suggested for use to appraise the overall model quality and paths significance, including χ^2/df (degree of freedom), Standardized Root Mean Square Residual (SRMR), Root Mean Square Error of Approximation (RMSEA), Comparative-Fit Index (CFI), Normed Fit Index (NFI), and Tucker and Lewis Index (TLI). Consequently, when the χ^2/df was lower than 5.0, CFI, TLI, and NFI were higher than 0.95. Furthermore, RMSEA and SRMR were smaller than 0.05. Thus, the longitudinal cross-lagged path model was good. Moreover, the model indicated the wellness of the proposed model reproducing the observed longitudinal data.

The longitudinal cross-lagged model exhibited the great goodness-fit indexes without controlling for the four covariates, $\chi^2 (2075) = 9695.001$, $p < 0.001$, $\chi^2/df = 4.672$, CFI = 0.973, NFI = 0.966, TLI = 0.970, RMSEA = 0.021, and SRMR = 0.031.

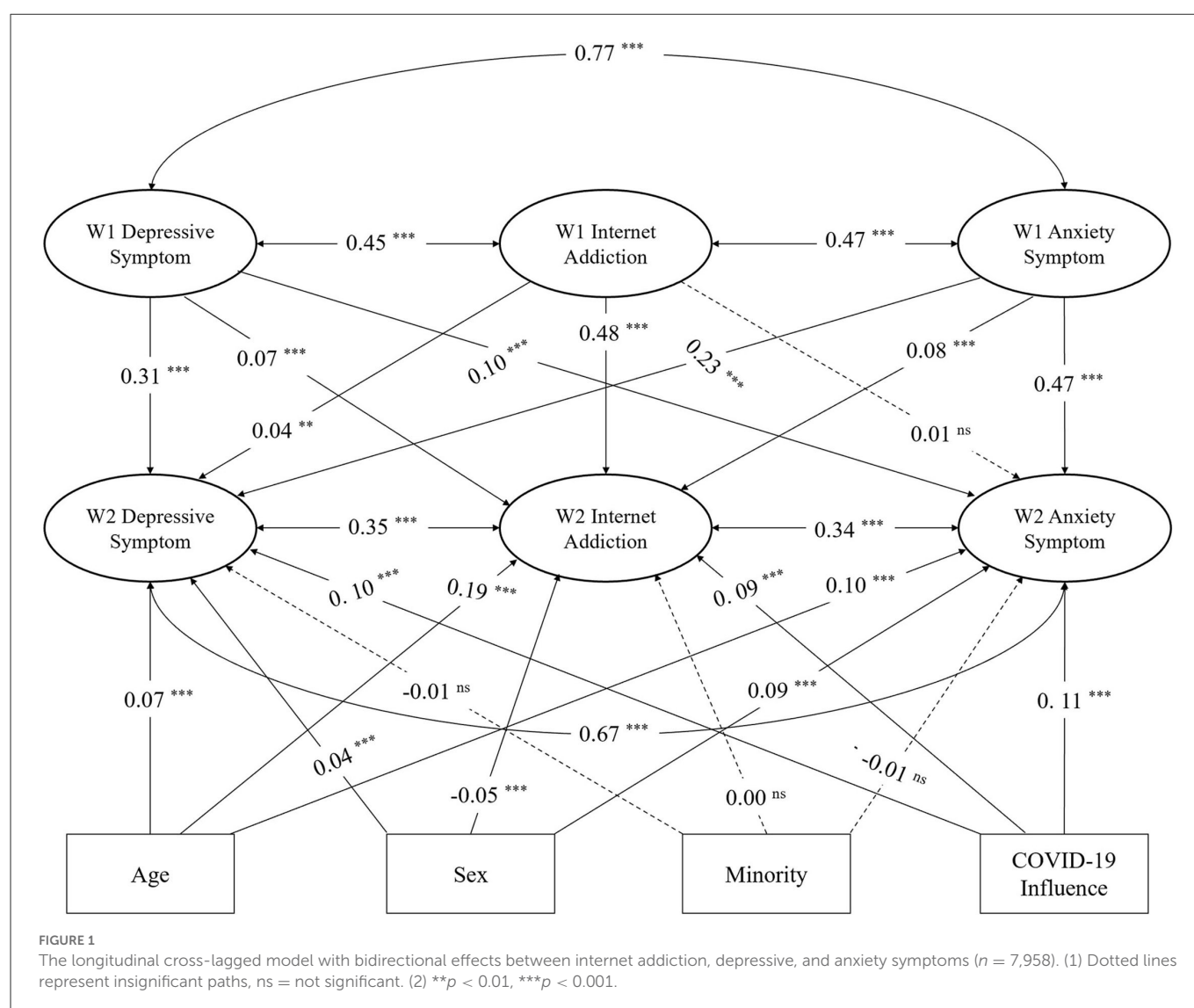
Furthermore, the model fit was good after controlling for these four covariates, $\chi^2 (2323) = 11221.203$, $p < 0.001$, $\chi^2/df = 4.830$, CFI = 0.969, NFI = 0.961, TLI = 0.966, RMSEA = 0.022, SRMR = 0.031. Moreover, Figure 1 illustrates the results of concurrent relations between study variables. Consequently, this study found significant concurrent associations between internet addiction and depressive symptoms in W1 ($r = 0.45$, $SE = 0.022$, $p < 0.001$) and W2 ($r = 0.35$, $SE = 0.013$, $p < 0.001$). Internet addiction also showed significantly co-instantaneous links with anxiety symptoms in W1 ($r = 0.47$, $SE = 0.016$, $p < 0.001$) and W2 ($r = 0.34$, $SE = 0.012$, $p < 0.001$). Thus, this study found significant co-current links between depressive and anxiety symptoms in both W1 ($r = 0.77$, $SE = 0.005$, $p < 0.001$) and W2 ($r = 0.67$, $SE = 0.003$, $p < 0.001$).

Figure 1 represents the cross-lagged model analysis, which suggests that internet addiction in W1 significantly and positively predicts internet addiction ($\beta = 0.48$, $SE = 0.002$, $p < 0.001$) and depressive symptoms ($\beta = 0.04$, $SE = 0.003$, $p = 0.002$) in W2. However, the model was not significant with anxiety symptoms in W2 ($\beta = 0.01$, $SE = 0.002$, $p = 0.365$). Furthermore, depressive symptoms in W1 significantly and positively predicted depressive symptoms ($\beta = 0.31$, $SE = 0.016$, $p < 0.001$), internet addiction ($\beta = 0.07$, $SE = 0.091$, $p < 0.001$), and anxiety symptoms ($\beta = 0.10$, $SE = 0.015$, $p < 0.001$) in W2. Moreover, anxiety symptoms in W1 had significant and positive predictive links with anxiety symptoms ($\beta = 0.47$, $SE = 0.025$, $p < 0.001$), internet addiction ($\beta = 0.08$, $SE = 0.145$, $p < 0.001$), and depressive symptoms ($\beta = 0.23$, $SE = 0.025$, $p < 0.001$) in W2. Consequently, these results supported H4, H6, and H7 but rejected H5.

Discussion

Based on the cross-lagged path model, this study provided further insight into the concurrent and longitudinal association between internet addiction and symptoms of anxiety and depression. Furthermore, the current study examined the developing trend of several study variables among Chinese adolescents before and during the COVID-19 pandemic. Based on existing knowledge, this study comprises the first large-scale longitudinal study to explore these issues in China. These findings could contribute critical suggestions to elucidate the three inter-related study variables. Moreover, the results can inform program designs underlying internet addiction prevention aimed at Chinese adolescents exposed to COVID-19.

The study findings indicated that the existence of severe depressive symptoms before COVID-19 significantly influenced the



severity of internet addiction during the pandemic. This result was consistent with most previous research that found significant and positive relations between depressive disorders and internet addiction (36). For example, a systematic review analyzed 18 related studies to investigate the positive links between internet addiction and depressive disorders (36). Furthermore, some studies supported that depression positively predicted internet addiction in Asian regions (37–39). These findings have been explained in previous studies. For example, adolescents with depressive symptoms usually exhibited a persistent low mood, feeling of sadness, lack of belongingness, and loss of interest in real life (39). Moreover, the Internet provided a virtual world to adolescent users, in which adolescents with depression could access supportive social networks and the pleasure of control while ignoring emotional difficulty and escaping from reality. Furthermore, a study reasonably suggested that adolescents with higher depressive symptoms were more likely to have more severe internet addiction (36). Additionally, the “short” alleles of the serotonin-transporter-linked promoter region (5-HTTLPR) were significantly and simultaneously linked with depressive disorders (40) and internet addiction (41). Moreover, the

5-HTTLPR gene was closely related to serotonin function suggesting that the biological weakness in both depressive symptoms and internet addiction could be associated with serotonin dysfunction (41). In turn, this could explain the results discovered in the current study. Therefore, future studies should focus on reducing depressive symptoms that could serve as a precautionary approach to internet addiction and evaluating the depressive degree among adolescents with internet addiction.

Consistent with previous studies, the current study found that severe pre-existing anxiety symptoms before the COVID-19 pandemic significantly predicted a higher level of internet addiction during COVID-19 among adolescents (39, 42, 43). For example, a longitudinal study indicated that anxiety symptoms positively predicted the emergence of internet addiction in the two-year prospective follow-up survey (44). Furthermore, Yayan et al. (45) found that adolescents with problematic symptoms of internet usage had inferior interpersonal relationships or anxious social phobias in the real world. Thus, adolescents with symptoms of social phobia tried to evade the anxiety emerging from face-to-face communication with people through the internet which could

provide virtual social support (36). Other research reported that adolescents experienced mentally internalizing issues (e.g., anxious symptoms) when they suffered from the social interaction dilemma in real life (46). Adolescents tended to use the internet (i.e., entertaining activities, relaxing social networks, and anonymously abreacting vents) to mitigate internal mental problems such as anxiety (47). Consequently, this explains the positive association between anxiety and internet addiction found in the current study. Potentially, these findings suggest that social interaction mediated or moderated the association between anxiety symptoms and internet addiction. Thus, future studies should investigate this mechanism further through a longer-term follow-up. Simultaneously, social anxiety-related intervention should be enhanced further when conducting clinical psychotherapy for internet addiction.

Interestingly, the present study demonstrated that internet addiction before COVID-19 was a positive predictor of depressive symptoms but did not significantly predict anxiety symptoms during COVID-19. Previous studies have proved the significant relationship between depression and Internet addiction (36, 37). People tended to excessively use the internet as a dysfunctional handling approach to alleviate negative emotional symptoms such as depression during COVID-19. Similarly, people exposed to internet overuse could suffer from more intrapersonal conflicts in the real world (37). Consequently, this finding indicated a vicious cycle in which depressive symptoms and internet addiction disorder upsurge each other (16). Thus, future studies should provide further insight into the mechanism underlying internet addiction and comorbidity properties with depressive symptoms as this could benefit the development of internet addiction interventions. In contrast, most previous research found that internet addiction was significantly associated with anxiety (14, 48, 49). Furthermore, previous research has provided possible explanations for this result. For example, internet addiction was probably not the priority factor directly resulting in anxious emotions among adolescents during COVID-19 (16). Particularly, the study found that the fear of COVID-19 significantly mediated the association between anxiety symptoms and internet addiction disorder (16). Moreover, a persistently increasing tendency to other daily life concerns during the COVID-19 pandemic was found, namely, psychical health insecurity, family economic pressure, quarantine fear, and academic future uncertainty. Thus, other factors could be more influential and predictive in the context of anxiety symptoms among adolescents over internet addiction.

Previous literature provided evidence that internet addiction was identified as a significant predictor of subsequent depressive symptoms, but was not significant in the anxiety symptoms. Based on the perspectives of biological genes, neurosciences, and society, many previous psychiatric studies consistently evidenced the predictive association between internet addiction and major depressive symptoms (36, 37, 40, 41). For example, prior research indicated the predictive links between internet addiction and depression disorders when controlling other demographics (e.g., sex, age, and school) among adolescents in Taiwan (50). In addition, whether internet usage is significantly linked with anxiety is still inconclusive among adolescents (10, 11, 51). For example, some research found significant links between internet addiction and concomitant anxiety disorders (48, 49). However, some studies reported an insignificantly predictive association between social anxiety and internet addiction when controlling for depression

and attention deficit hyperactivity disorder (44). Another previous research included 59 students with internet addiction symptoms and found depressive symptoms were increasing, but their phobic anxiety did not show any changes in the study period (52). These findings might indicate that other psychiatric factors could be more vital predictors of anxiety symptoms than internet addiction among adolescents during COVID-19. In any case, the predictive mechanisms between internet addiction and anxiety symptoms deserve further attention in different contexts in the future.

This current study demonstrated a decreased trend in depressive and anxiety symptoms but an increased tendency in internet addiction from before COVID-19 to during COVID-19. The rising trend in internet addiction was consistent with previous studies on COVID-19 (4, 6). However, the results demonstrating deteriorated psychological problems were inconsistent with many previous studies (11, 53, 54). Possibly, these results occurred because adolescents could spend more time on internet usage during home quarantine and online studies imposed by the COVID-19 pandemic. Consequently, this could increase the risk of experiencing internet addiction (5). Furthermore, increased time for adolescents to stay with their families could improve family support and thus remit mental problems such as depressive and anxiety symptoms among Chinese adolescents during COVID-19 (5). Additionally, there are two possible reasons why anxiety symptoms were reduced during the COVID-19 compared prior COVID-19 pandemic. First, some positive factors that are usually provided to alleviate anxiety symptoms could be suddenly present or more accessible during the COVID-19 lockdown (e.g., more family time and siblings' support) (55). Second, some negative factors that could arouse anxiety symptoms before this pandemic were not as strong or did not present (e.g., school work, interpersonal relationships, and academic stress) (55, 56). Moreover, several studies reported on the diminished prevalence of mental disorders among adolescents exposed to COVID-19 (55–57). Thus, future studies should conduct a study with longer-term follow-up to track the development of internet addiction as well as depression and anxiety symptoms. Particularly, increased psychological intervention should be provided to adolescents to prevent internet-based addictive behaviors during COVID-19.

Another notable finding was that anxiety levels significantly decreased but depression levels did not significantly decline across the two study waves. One possible explanation for this result was that the lockdown policy could bring different influences on depressive and anxiety symptoms among Chinese adolescent students during COVID-19 (55). The lockdown policy made adolescents study at home, which could effectively decrease the anxious symptoms resulting from offline study and interpersonal relationships on campus (55). However, the discordant family atmosphere could be adverse to the remission of depressive symptoms when adolescents have to stay at home during COVID-19 pandemic (5). A future study was suggested to further track different development trends and key influence factors in depressive and anxiety symptoms among Chinese adolescents exposed to COVID-19. Additionally, consistent with some prior studies (16, 36), the results revealed the bidirectional and positive links between internet addiction, depressive and anxiety symptoms in each wave survey. This indicated the possible coexistence of psychiatric problems (e.g., depression and anxiety) and Internet addiction (36). These possible coexisting

psychological problems should be paid more attention when treating adolescents with internet addiction symptoms.

Limitations

The current study had several limitations. First, a self-report questionnaire was used for data collection. Furthermore, the symptoms of depression, anxiety, and internet addiction depended on the scale screening, rather than a clinical diagnosis. Consequently, the scale could influence the accuracy of the prevalence of mental disorders. Thus, future studies should suggest a mixed method design (i.e., qualitative and quantitative studies) and select more clinical diagnosis tools for mental disorder prevalence screening. Second, this study did not include all mental factors influencing internet addiction identified in prior literature because of the limited questionnaire length. Thus, future studies could further explore the association between internet addiction and trauma-related disorders, such as acute stress disorder, post-traumatic stress disorder, and adjustment disorder using a longitudinal survey. Third, the effects of the COVID-19 pandemic were controlled for assessing the links between internet addiction, anxiety, and depressive symptoms. However, it should be noted that all samplings were exposed to the COVID-19 pandemic. Thus, the effects of mental health disorders could not be completely detached from the influences of the comprehensive exposure to this pandemic. Fourth, there was a relatively large correlation between depressive and anxiety symptoms in this current study. When two highly correlated symptoms are included in one cross-lagged model, the results could be influenced. It was suggested to combine both symptoms as psychological distress or separate them as depression and anxiety symptom models to further explore this issue in the future (58). Finally, the current data only included two waves, namely, before and during COVID-19. Thus, future studies should exhibit the different relationships between the study variables using longer-term follow-up surveys to further demonstrate these robust links.

Conclusion

Despite the study limitations, the current study contributed new knowledge to prior theoretical and empirical exploration of the association between internet addiction, anxiety, and depressive symptoms. These findings emphasized that the psychological status before COVID-19 serves as a potential vital signal for internet addiction among adolescents during this pandemic and extended the explanation power of the Problem-Behavior Theory and the I-PACE model for internet-related addictive behavior. Considering the proposed intervention, future studies should examine the longer-term mental health consequences of COVID-19 to improve the early warning of internet addiction among adolescents in the context of a public health emergency. Moreover, internet-related clinical psychotherapeutic efforts should focus on the remission of depressive symptoms among Chinese adolescents during a pandemic.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Ethics statement

The studies involving human participants were reviewed and approved by the Research Ethics Committee of the University (Approval No. K2020025). Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

LZ did study design and data collection. WS analyzed data, drafted, and submitted this manuscript together. LZ, XL, YP, and QY revised the manuscript. All authors contributed to manuscript checking and approval the final manuscript.

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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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Internet gaming disorder and aggression: A meta-analysis of teenagers and young adults

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Background and aims: Internet gaming disorder (IGD) and aggression (AG) are widespread phenomena around the world. Numerous studies have explored the relationship between the two but findings from such studies are inconsistent. The meta-analysis aimed to evaluate the relationship between IGD and AG as well as identify the variables moderating the relationship.

Method: Studies investigating the relationship between IGD and AG were searched using selected terms to identify studies published from 1999 to 2022 on CNKI, Wanfang Data, Chongqing VIP Information Co., Ltd. (VIP), Baidu scholar, ProQuest dissertations, Taylor & Francis, Springer, Web of Science, Google Scholar, Elsevier Science (Science Direct), EBSCO, and PsycINFO. The identified studies were pooled and analyzed.

Results: A total of 30 samples comprising 20,790 subjects were identified. Results showed that there was a moderate relationship between IGD and AG ($r=0.300$, 95%CI [0.246, 0.353]). Moderator analysis revealed that the relationship between IGD and AG was moderated by the region, age, and survey year.

Conclusion: This meta-analysis indicated that people with a higher level of IGD might show more aggression, and people with more aggression might have a higher level of IGD. The correlation coefficient between IGD and AG was significantly higher in Asia than in Europe, higher in primary school than in middle school and university, and higher by increasing year. Overall, our findings provide a basis for developing prevention and intervention strategies against IGD and AG.

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KEYWORDS

internet gaming disorder, aggression, meta-analysis, teenagers and young adults, online game addiction

1. Introduction

According to a survey by the United Nations Educational, Scientific and Cultural Organization (UNESCO), 32% of students (1) and about 246 million children experience physical violence and bullying at school every year (2). Globally, youth violence and bullying are major challenges affecting the public health and education sectors (2, 3). Bullying and violence

are forms of aggression (AG) (4). The prevalence of AG has been on the increase annually (5, 6). AG is detrimental to an individual's physical and mental health as well as career development (7, 8). Therefore, researchers should explore avenues for controlling and reducing the rates of AG.

Previous studies mainly evaluated the causes of AG from personal and environmental perspectives (9–13). Internet games belong to virtual environments. Adolescents are prone to addiction to the virtual online world and their rate of addiction has been increasing yearly (14, 15). Therefore, Internet Gaming Disorder (IGD) is considered an influencing factor for development of aggressive behaviors among adolescents (16, 17). Some empirical studies have shown that IGD was highly associated with AG (18–20). This is possibly because aggressive individuals have poor interpersonal relationships and low self-efficacy in real life, therefore they seek their self-worth and obtain self-efficacy through virtual Internet games (21). Players may acquire the feeling by engaging in games, which makes their behaviors repetitive, leading to IGD (22). On the other hand, IGD may have various negative impacts including aggression, hostility, and antagonistic behaviors (23), which may be explained by the General Aggression Model (24). Aggressive characteristics are part of a person's personality, and are correlated with immediate aggressive behaviors and long-term aggressive personalities (25). Among the Internet games, students tend to prefer violent games (26). Negative scenarios in Internet games can trigger attacks and hostile behaviors among individuals in real life. In contrast, some studies reported weak relationships (27, 28) or even a negative correlation between IGD and AG (29). This can be explained by the catharsis theory of play which states that individuals use Internet games to reduce stress or satisfy controlling needs that have not been met in real life. Gamers use online games as a means to reduce stress, and some stressed, unhappy, or mentally ill people are more inclined to use Internet games to release stress (30). People who play more games are better capable of handling stressful tasks in laboratory settings (31). Young moderate gamers tend to have better mental health outcomes than non-gamers or excessive gamers (32). As a result, the negative emotions and aggressive behaviors may be moderately relieved.

The nature of the relationship between IGD and AG has not been conclusively determined, which may be due to the small number of participants in single surveys. Therefore, we performed this meta-analysis to integrate previous empirical studies of IGD and AG to provide stronger scientific conclusions about the relationship between IGD and AG.

Inconsistencies in IGD and AG relationships among studies may also be attributed to differences in measurement tools used for IGD and AG as well as differences in subjects' demographic characteristics (33, 34). We hypothesized that the relationship between IGD and AG is affected by one or more variables. Specifically, this relationship may be influenced by: (i) The choice of IGD and AG measures; (ii) Demographic profiles of participants. We explored the moderating role of the four demographic variables: year, gender, region, and age.

1.1. Measures of IGD and AG

In 2013, the American Psychiatric Association (APA) first included IGD in the Diagnostic and Statistical Manual of Mental Disorders Fifth Edition (DSM-5). DSM-5 considers IGD to be an excessive and prolonged mode of Internet gaming in which individuals with IGD experience exhibit multiple cognitive and behavioral

symptoms, such as gradual loss of control over gaming, tolerance, and withdrawal symptoms. It contains 9 diagnostic criteria: Addiction to Internet games; Withdrawal symptoms; Tolerance; Failed attempts to control Internet games; Loss of interest in other activities; Ignoring existing psychosocial problems and continuing to overuse online games; Deception for the sake of the game; Escape from destructive emotions; Endangering or losing an important relationship or opportunity for work or education due to online games. A person who meets five or more criteria in the past 12 months is considered to be suffering from IGD (35). Based on the nine diagnoses of IGD in DSM-5, various assessment tools for IGD have been developed. For example, Pontes and Griffiths developed the nine-item Internet Gaming Disorder Scale—Short-Form (IGDS9-SF) (36). Lemmens and colleagues developed 4 questionnaires including two long scales (27 items) and two short scales (9 items) that have good reliability and validity (37). These scales can be divided into two types: polytomous and dichotomous. Later, Lemmens compiled another Game Addiction Scale (GAS), which includes a complete version consisting of 21 factors and a short version consisting of 7 factors. Both scales showed good reliability and validity (38). One of the most widely used IGD scales in the Chinese mainland is Cui's Internet addiction diagnostic scale (IADS), which was developed based on Young's Diagnostic Questionnaire and revised by the Angoff method (39, 40).

Aggression refers to actions that are intended at physically or psychologically harming others (41). When studying the relationship between IGD and AG, the early and frequently used AG measurement tool is the Buss-Durkee Hostility Inventory (BDHI). The BDHI which includes seven assault dimensions (indirect hostility, irritability, negativism, resentment, suspicion, verbal hostility and guilt), is used to assess the intensity and performance of hostility as well as AG (42). Since this scale did not perform factor analysis on each item, Buss and Perry compiled the BPAQ based on BDHI to improve the performance of the AG assessment tool (43). It consists of 29 questions with four dimensions: physical aggression, verbal aggression, anger and hostility. The BPAQ has been verified and is used worldwide. Other commonly used AG scales include the Reactive-Proactive Aggression Questionnaire (44, 45), the Normative Beliefs About Aggression Scale (46), Barratt Impulsiveness Scale (47) and State-Trait Anger Expression Inventory (48).

In summary, different measurement tools have different theoretical, dimension constructions and number of questions. These differences may have an impact on the relationship between IGD and AG to a certain extent. Therefore, we analyzed the moderating effects of measurement tools on IGD and AG.

1.2. Demographic variables as moderators

Demographic variables include the region, age, year and gender of the subject. Differences across regions may cause significant differences in the relationship between IGD and AG. Studies in Asia and Europe have reported contrasting findings on correlations between IGD and AG (18, 49, 50). For instance, some studies in Asia reported moderate positive correlations between IGD and AG (51, 52). However, in Europe, a low degree of positive correlation between IGD and AG was reported (27). Therefore, we hypothesized that the relationship between IGD and AG varies significantly across regions.

Differences in age may lead to significantly different relationships between IGD and AG. Among college and middle school students, the

IGD and AG correlate to varying degrees (19, 52). Some studies reported a low positive correlation between IGD and AG among middle school and college students (27, 28). Other studies found a moderate positive correlation between IGD and AG in middle school and college students (18, 53). Therefore, we explored whether there are significant age-associated differences with in terms of the relationship between IGD and AG.

Gender differences can also cause significant differences in the relationship between IGD and AG. Different correlations between male and female students with IGD and AG have been reported (51, 53). Some studies reported low positive correlations between men's IGD and AG (28), whereas others proved that women's IGD and AG are moderately positively correlated (54). Therefore, we investigated whether there are significant gender-associated differences in the relationship between IGD and AG.

Finally, the year may be a moderating variable affecting the relationship between IGD and AG. Some studies have shown that the correlation between IGD and AG increases annually (28, 49, 55) whereas other studies reported that the relationship between IGD and AG decreases each year (20, 50, 56). Therefore, we investigated the differences in IGD and AG between students in different years.

Therefore, we conducted a meta-analysis on studies investigating the relationship between IGD and AG to: (i) Determine the effect size and direction of the relationship between IGD and AG and (ii) Determine how various factors (measurement tools, region, age, gender, year) affect the relationship between IGD and AG?

2. Methods

This meta-analysis was performed in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement. To increase transparency and prevent unintended duplication of efforts, the protocol used in this meta-analysis was preregistered at the International Prospective Register for Systematic Reviews (PROSPERO) (CRD:42022375267).

2.1. Literature search

We searched the CNKI, Wanfang Data, Chongqing VIP Information Co., Ltd. (VIP), Baidu scholar, ProQuest dissertations, Taylor & Francis, Springer, Web of Science, Google Scholar, Elsevier Science (Science Direct), EBSCO and PsycINFO databases to retrieve relevant studies investigating the relationship between AG and IGD published from January 1999 to November 2022. The key search terms for IGD were: online game addiction, Internet game disorder, digital game addiction, problematic Internet game use, Internet game dependence, video game addiction, excessive Internet game use and computer game addiction. The main search terms for AG were: aggression, impulsiveness, anger, conflict, attack, hostility, violence, aggressiveness, aggressive action, aggressive behavior, behavior disorder, behavior problems, conduct disorder, anti-social behavior and oppositional defiant disorder.

The study inclusion criteria were: (i) Studies that simultaneously used IGD and AG scales, and the Pearson product-moment correlation coefficient or the *t*-value and *F*-value that could be converted into *r* were reported; (ii) Studies that reported on sample

sizes; (iii) Studies that involved participants who were normal, excluding other groups such as patients and criminals; and iv. For data that were repeatedly published, only one set published in a professional academic journal was chosen. Finally, 24 papers with 30 samples met the meta-analysis criteria. The PRISMA flow chart of the systematic search is shown in Figure 1.

2.2. Coding variables

The collected literature were coded by characters, including author names, survey years, publication dates, regional distribution, document types, age of participants, sample sizes, correlation coefficients, measuring tools for IGD and AG as well as the percentage of female students in the overall population (Table 1). Effect values were extracted according to the following criteria: First, the correlation coefficients between IGD and AG were included in the coding. Second, independent samples were coded once. If multiple independent samples were reported at the same time, they were separately coded. Lastly, when calculating the effect value for each category, each original datum appeared only once under each category to ensure the independence of effect value calculation.

2.3. Quality assessment of included studies

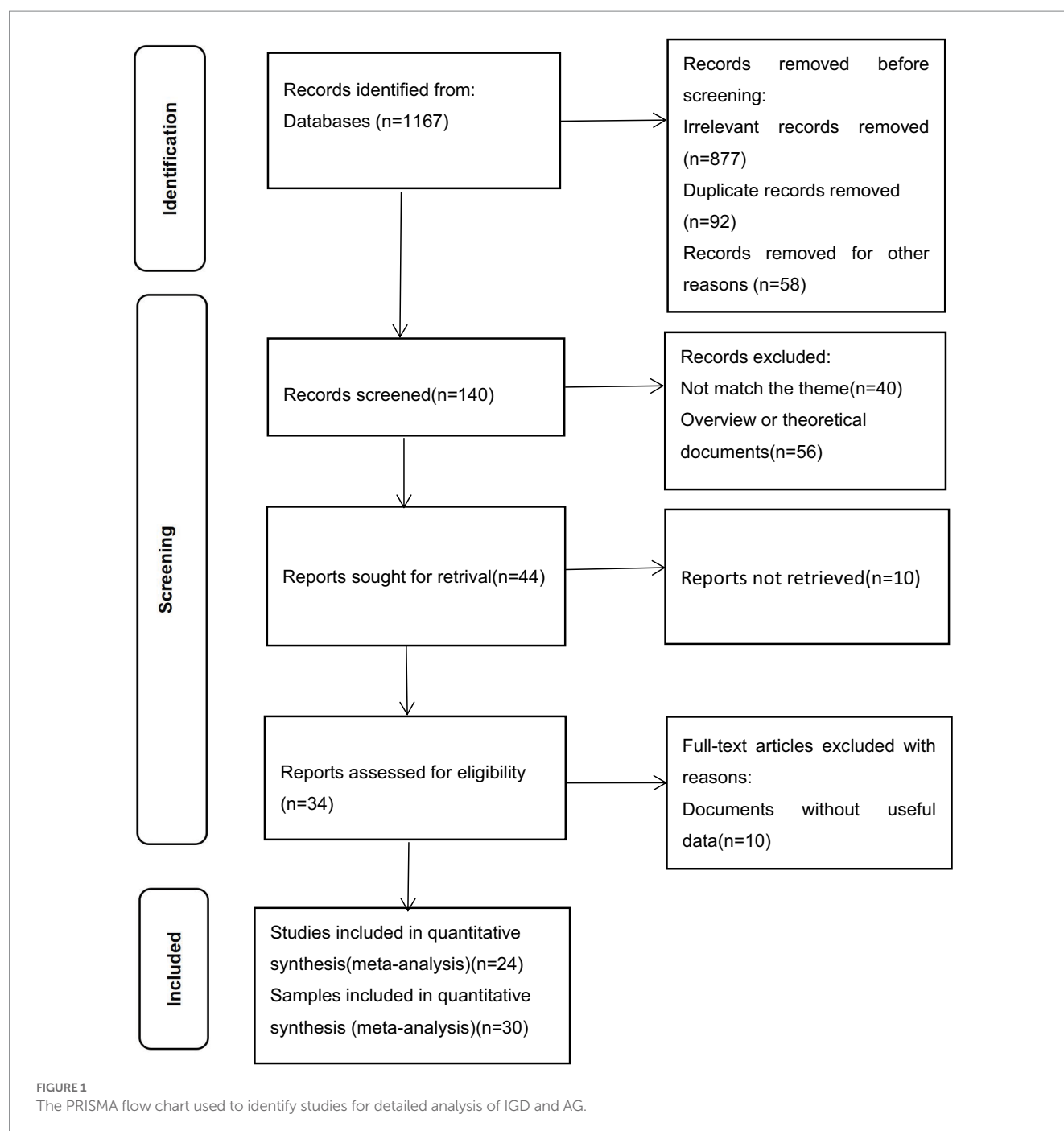
Literature quality assessment was performed using the Joanna Briggs Institute (JBI) Critical Appraisal Tool (64). The checklist consists of eight items, each with four options. Questions such as "Were the study subjects and settings described in Detail?" and "Was the statistical analysis appropriate?," were asked of the studies. The "Yes" option scored 2 points, "Unclear" scored 1 point, while "No" or "Not applicable" scored 0 points. The lowest score was 0 points, while the highest score was 16 points. The literature quality assessment process was independently by two researchers. In case of disagreements, a consensus was reached through discussions. All the 24 studies scored more than 13 points. Quality assessment was not used to exclude any studies but was conducted to enhance the evaluation and discussion.

2.4. Effect size calculation

The Pearson product difference correlation coefficient (*r*) was used to calculate the effect sizes (65). The *r* value was transformed by Fisher's *Z*, calculating weights and 95% confidence intervals based on the sample size Conversion formula: $Zr = 0.5 \cdot \ln[(1+r)/(1-r)]$, $VZ = 1/n-3$, $SEz = \sqrt{1/n-3}$, whereby *Zr* denotes the converted value of the corresponding *r*, *VZ* is the variance, and *SEz* is the standard error.

2.5. Data processing and analysis

Data were analyzed using the meta-analysis software, CMA 3.0. To test whether each study result was representative of an estimated sample of the overall effect size, a homogeneity test was performed. The homogeneity test provides a basis for whether the results were fixed-effect or random-effects models. In case of homogenous effect



values, the fixed-effect model was selected. If heterogeneity was considerable, a random-effects model was used. The homogeneity test also provides a basis for analysis of moderating effects, while a large heterogeneity indicates the existence of moderating effects (66).

3. Results

3.1. Effect sizes and the homogeneity test

A total of 24 papers which reported on the relationship between IGD and AG, with 30 sample sizes were identified. A total

of 20,790 participants were included in the studies, with the number of subjects ranging from 41 to 3,320 subjects. Table 2 shows 30 independent samples of IGD and AG. The homogeneity test revealed a Q statistics value of 483.906, $p < 0.001$, $I^2 = 94.007$, indicating heterogeneity in the included studies. This may be due to the different measurement tools used in literature, the source of participants and different sample sizes. That is, there may be a moderating effect. Based on the methodology provided by Lipsey and Wilson, the included literature was highly heterogeneous and was analyzed by random models (66).

The random model revealed that the correlation between IGD and AG was significant, with correlation coefficients of 0.300, 95%CI [0.246, 0.353]. This relationship is potentially moderate (66). The

TABLE 1 Characteristics of the 30 samples included in the meta-analysis.

Number	Name (year)	Survey year	Journal	Region	Grade ^a	N	Female ^b	IGD scale	AG scale	r
1	Agarwal et al. (2019) (29)	2017	General	Asia	1	100	Nope	GAS	BPAQ	−0.025
2	Bao (2009) (57)	2007	Dissertation	Asia	1	339	0.379	IADS	BPAQ	0.250
3	Cancer et al. (2021) (18)	2020	General	Asia	2	856	Nope	GAS	BPAQ	0.436
4	Chew et al. (2022) (50)	2020	General	Asia	4	123	0.569	IGDS9-SF	BPAQ	0.290
5	Cui et al. (2006) (39)	2004	General	Asia	2	41	Nope	IADS	BPAQ	0.255
6	Evren1 et al. (2019) (58)	2018	General	Asia	1	987	0.426	IGDS9-SF	BPAQ	0.318
7	Hassan (2021) (51)	2019	General	Asia	1	150	0.500	GAS	BPAQ	0.320
8	Khazaal et al. (2016) (27)	2010	General	Europe	4	3,320	Nope	GAS	Others	0.090
9	Khazaal et al. (2016) (27)	2010	General	Europe	4	2,670	Nope	GAS	Others	0.150
10	Kim et al. (2008) (21)	2006	General	Asia	4	1,471	0.173	Others	BPAQ	0.350
11	Kim et al. (2018) (56)	2016	General	Asia	2	402	0.445	IGDS9-SF	BPAQ	0.320
12	Lemmens et al. (2009) (38)	2007	General	Europe	2	352	0.330	GAS	BPAQ	0.257
13	Lemmens et al. (2009) (38)	2007	General	Europe	2	352	0.330	GAS	BPAQ	0.265
14	Lemmens et al. (2009) (38)	2008	General	Europe	2	369	0.320	GAS	BPAQ	0.205
15	Lemmens et al. (2009) (38)	2008	General	Europe	2	369	0.320	GAS	BPAQ	0.188
16	Mahamid et al. (2020) (54)	2018	General	Asia	4	560	0.693	GAS	BPAQ	0.380
17	Ohno (2021) (52)	2019	General	Asia	4	874	0.486	IGDS9-SF	Others	0.320
18	Su et al. (2018) (59)	2016	General	Asia	2	323	0.529	Others	Others	0.270
19	Teng et al. (2014) (60)	2012	General	Asia	1	211	0.000	Others	BPAQ	0.270
20	Wallenius et al. (2008) (61)	2004	General	Europe	4	478	0.544	Others	Others	0.280
21	Wallenius et al. (2008) (61)	2006	General	Europe	4	316	0.570	Others	Others	0.130
22	Wang (2010) (55)	2008	Dissertation	Asia	1	62	0.403	Others	BPAQ	0.387
23	Wang (2011) (20)	2009	Dissertation	Asia	1	375	0.304	IADS	BPAQ	0.547
24	Wu (2007) (28)	2005	Dissertation	Asia	4	192	0.344	IADS	BPAQ	0.112
25	Yilmaz et al. (2018) (62)	2016	General	Asia	2	276	Nope	Others	BPAQ	0.440
26	Yu et al. (2016) (63)	2014	General	Asia	2	2024	0.494	IGDS9-SF	BPAQ	0.260
27	Yuh (2018) (53)	2016	General	Asia	2	263	0.000	Others	BPAQ	0.260
28	Zhang (2020) (19)	2019	Dissertation	Asia	3	1,080	0.470	Others	Others	0.391
29	Zhang (2020) (19)	2019	Dissertation	Asia	3	1,080	0.470	Others	Others	0.408
30	Zhang (2021) (19)	2019	General	Asia	1	775	0.512	Others	BPAQ	0.610

^a1 = university students; 2 = middle school students; 3 = primary school students; 4 = mixed. ^bnope, not reported.

Z-value of IGD and AG relationship was 10.287, $p < 0.001$, indicating that the relationship between IGD and AG is stable (Table 2).

3.2. Moderator analysis

As described in section 2.4, the random effects model was applied in the intermediary effects analysis. Meta-ANOVA analysis is suitable for analyzing the moderating effects of categorical variables, such as types of measurement tools, subject groups, and regional differences.

In contrast, meta-regression analysis is suitable for analyzing continuous variables' moderating effects, such as proportions of females and survey year.

3.3. Meta-ANOVA analysis

To determine the moderating effects of the relationship between IGD and AG, Meta-ANOVA analysis was performed for the categorical variables (Table 3).

TABLE 2 Model of the correlation between IGD and AG.

k	N	Mean <i>r</i> Effect size	95% CI for <i>r</i>	Homogeneity test			Tau-squared			Test of null (two-tailed)
				Q(<i>r</i>)	<i>p</i>	I-squared	Tau-squared	SE	Tau	Z-value
30	20,790	0.300	[0.246, 0.353]	483.906	0.000	94.007	0.024	0.009	0.154	10.287***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$, the same as follows.

The homogeneity test ($Q = 16.724$, $df = 1$, $p < 0.001$) revealed that regions moderated this correlation. Correlation coefficients between IGD and AG for Asian and European subjects were 0.342 (95% CI = [0.291, 0.392]) and 0.189 (95% CI = [0.136, 0.241]), respectively, indicating that $r_{\text{Europe}} < r_{\text{Asia}}$.

The homogeneity test ($Q = 19.138$, $df = 3$, $p < 0.001$) showed that age had moderating effects on this correlation. The correlation coefficients between IGD and AG for university, middle school and primary school students were 0.354 (95% CI = [0.207, 0.485]), 0.292 (95% CI = [0.236, 0.347]) and 0.400 (95% CI = [0.363, 0.434]), respectively, indicating that $r_{\text{middle school students}} < r_{\text{university students}} < r_{\text{primary school students}}$.

The homogeneity test ($Q = 3.953$, $df = 3$, $p > 0.05$) showed that measurement tools for IGD did not have moderating effects on this correlation, and the relationship between IGD and AG was not affected by measurement tools for IGD.

The homogeneity test ($Q = 1.068$, $df = 1$, $p > 0.05$) demonstrated that measurement tools for AG had no moderating effects on this correlation, and the relationship between IGD and AG was not affected by measurement tools for AG.

3.4. Meta-regression analysis

Meta-regression analysis was performed to determine whether the continuous variables had significant effects on the relationship between IGD and AG. Results showed that: (i) The effect of sex on the relationship between IGD and AG was not significant. It showed the proportion of women did not significantly influence the relationship between IGD and AG ($Q_{\text{Model}[1, k=24]} = 0.490$, $p > 0.05$; Table 4). (ii) The year was a significant factor moderating the relationship between IGD and AG. Meta-regression analysis showed (Table 4) that year significantly affected the relationship between IGD and AG ($Q_{\text{Model}[1, k=30]} = 5.380$, $p < 0.05$). Specifically, as the years increases, the correlation coefficient between IGD and AG also increases.

3.5. Assessment of publication bias

To determine whether the results were biased due to effect sizes from various sources, a funnel plot was drawn (Figure 2). The 30 effect sizes were symmetrically distributed on both sides of the average effect size, and Egger's regression test (67) did not reveal a significant bias [$t_{(28)} = 1.387$, $p = 0.176 > 0.05$]. To test for publication bias, this study calculated that the $Z = 38.953$ ($p < 0.001$) of Classic Fail-safe N. When 1820 missed studies were included, the analysis result was no longer significant (68). These findings showed that the overall correlation between IGD and AG was stable.

4. Discussion

4.1. The positive relationship between IGD and AG

Our results revealed a significant correlation between IGD and AG, consistent with previous studies (21, 54, 56). Yuh reported that individuals' AG can predict their IGD (53). From the Social Information Processing (SIP) Model of AG, people who perpetrate aggressive behaviors tend to choose negative social cues and hold attributional biases when facing ambiguous adverse events in life (44). Most of them may lack social problem-solving skills (69), have a low self-esteem (70) and experience negative interpersonal relationships (71). To escape the unsatisfactory real life, they are more likely to dedicate themselves to virtual Internet games, which may make them feel powerful to overcome difficulties and get rid of loneliness (72). From another perspective, most online games contain fighting, competition and violence, which promote the gamers' violent tendencies (73). The social learning theory suggests that people's aggressive behaviors are learned from observation (74). People are not born to be aggressive, but learn to behave violently from external circumstances. For instance, individuals who grew up in parenting-conflict environments might exhibit more aggressive behaviors than others (75, 76). From the perspective of cognitive-contextual framework, people also learn how to use force to solve difficulties in the violent gaming world. They may consider AG as the best solution to a problem or to acquire what they want (77). Besides, in Internet games, people can achieve extremely positive emotional experiences through violence without being actually punished, which may cause them underestimate the AG consequences and reinforce the urge to commit AG in real life (78). Therefore, people who are addicted to Internet games may show more AG in daily life.

4.2. Moderating effects

We found that region moderated the relationship between IGD and AG. Specifically, the correlation coefficient between IGD and AG in Asian participants was significantly higher compared with that of European participants. Compared with the European individualistic cultures, individuals in Asian collectivist cultures are less self-contained (79). To regulate their behaviors, they are more likely to be influenced by the context and surrounding people (80). Therefore, in the face of violent contexts in Internet games, young people in Asia may have a more challenging time maintaining their self-awareness and instead imitate those behaviors. Besides, studies have shown that individuals are weaker in self-monitoring in collectivist cultures than in individualistic cultures (81). Collectivist cultures in the Asian

TABLE 3 Region and age and measures moderators of the association between IGD and AG.

	Between-group effect (Q_{BET})	k		Mean r effect size	SE	95% CI for r		Homogeneity test within each group (Q_w)
						LL	UL	
Region	16.724***							
Asia		22		0.342	0.007	0.291	0.392	194.324***
Europe		8		0.189	0.004	0.136	0.241	32.349***
Age	19.138***							
University student		8		0.354	0.034	0.207	0.485	118.873***
Middle school student		11		0.292	0.005	0.236	0.347	43.423***
Primary school student		2		0.400	0.001	0.363	0.434	0.220
Mixed		9		0.237	0.011	0.152	0.318	131.651***
Measures of IGD	3.953							
GAS		10		0.235	0.014	0.147	0.319	138.872***
IADS		4		0.307	0.059	0.064	0.515	39.563***
IGDS9-SF		5		0.293	0.001	0.264	0.323	4.445
Others		11		0.354	0.012	0.272	0.430	119.511***
Measures of AG					1.068			
BPAQ		22		0.317	0.009	0.258	0.374	210.260***
Others		8		0.258	0.015	0.159	0.352	173.801***

*** $p < 0.001$.

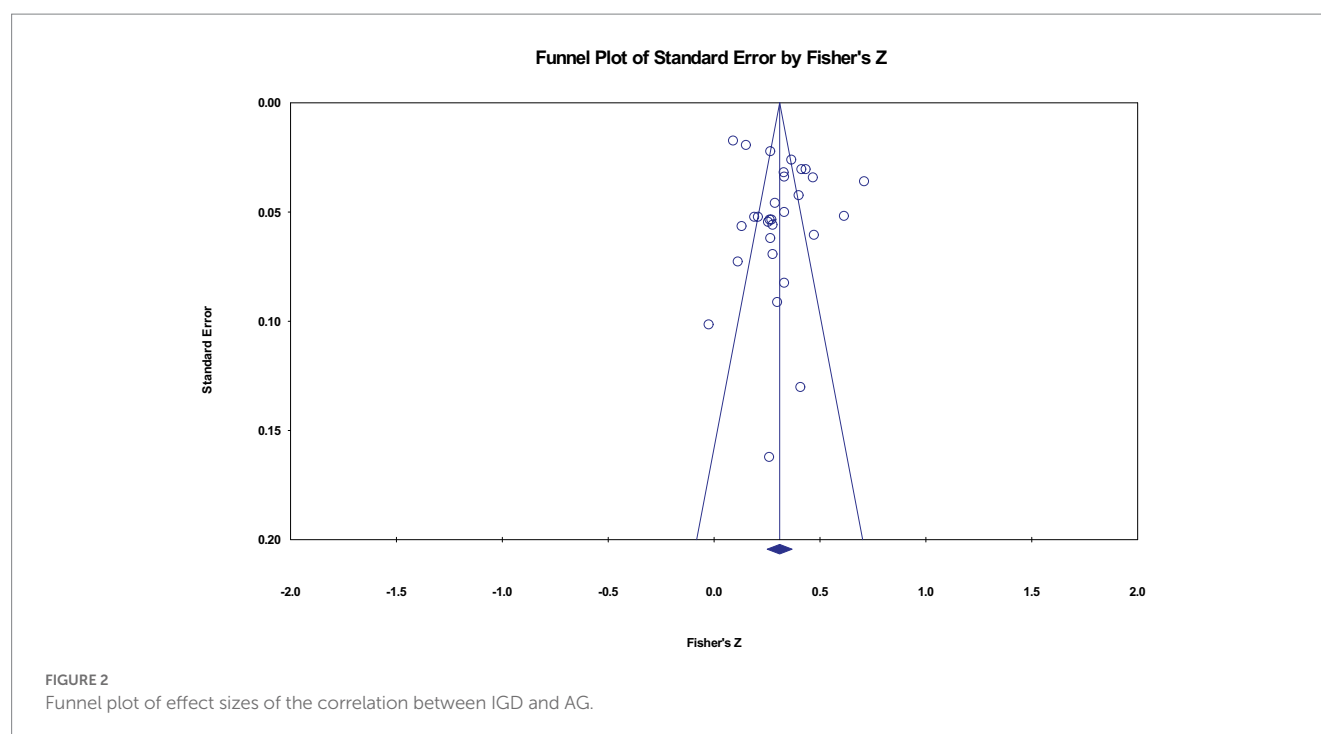
TABLE 4 Meta-regression analysis of gender and survey year.

Variables	Parameter	Estimate	SE	Z-value	95%CI for b	
					LL	UL
Female (%)	β_0	0.121	0.173	0.700	-0.219	0.461
	β_1	0.278	0.075	3.690	0.130	0.425
$Q_{Model}(1, k=24) = 0.490, p > 0.05$						
Survey year	β_0	0.011	0.005	2.320	0.002	0.021
	β_1	-22.159	9.684	-2.290	-41.139	-3.179
$Q_{Model}(1, k=30) = 5.380, p < 0.05$						

region encourage harmony and alignment to others. Individualized emotions, such as anger, are often suppressed. Compared with Western regions that value individuality and have fewer inhibitions on people's expression, individuals with IGD in Asia may find it harder to control themselves, thereby expressing repressed negative emotions and exhibiting aggressive behaviors. Compared to Asian countries, Western countries were the first to study and treat IGD. They established a better supervision mechanism, such as the Entertainment Software Rating Board (ESRB), which set a game rating system to help parents prevent and control minors' exposure to unhealthy games. Thus, teenagers who play games in Western countries may be less likely to be exposed to and learn about violent and aggressive behaviors in games. Finally, the moderating effects may be influenced by sample distribution. A total of 30 samples were included in this study (8 in Europe and 22 in Asia). The imbalance in sample distribution may affect the relationship between IGD and AG.

In addition, the results revealed that age moderated the relationship between IGD and AG. The correlation coefficient between

IGD and AG was highest among primary school students, followed by college students, and finally middle school students. People who are forced to stop Internet gaming may exhibit anger and aggression (82). Unfortunately, compared with college and middle school students, primary school students have the weakest self-control abilities (83), which makes them exhibit severe aggressive behaviors negative emotions and play games as a means to escape from these challenges. Thus, the vicious circle is more likely to occur among primary school students. We also found that college students perform worse than middle school students regarding the relationship between IGD and AG. That may be because when young people enter colleges, their parents reduce rule setting and discipline (84), making them rely on self-monitoring and self-management. Therefore, it may be challenging for young adults to prevent themselves from engaging in Internet games and problematic behaviors. In addition, our sample sizes for different age groups were not even. For instance, the sample size for primary school students was small, which may have affected the moderating effects of age on the relationship.



For the moderating role of survey year, results showed that the relationship between IGD and AG increased over time, which is consistent with findings from previous studies that IGD can predict aggressive behaviors, and that the relationship between the two is longitudinal and synchronous (60, 85). In the past two decades, advances in network technologies have been significant. The Internet has increasingly become the most commonly used work and entertainment tool for the public. According to the Digital 2022: Global Overview Report data, between 2012 and 2022, the number of Internet users worldwide increased from 2.18 billion to 4.95 billion (86). During the period from 1998 to 2016, the prevalence of IGD increased from 0.7 to 15.6% (87). Spending too much time on the screen for children and adolescents may promote their psychological and behavioral problems (88). Therefore, with development of the Internet, young people's addiction to Internet games may increase the correlation between IGD and AG. In addition, teenagers and young adults experience more stress and anxiety compared to previous years, which may emotional and behavioral distress (89). The increasing stress levels may be a potential reason for strengthening the relationship between IGD and AG.

4.3. Limitations and future studies

This study applied the Egger's publication bias test which revealed that there was no significant publication bias in the included studies and that the meta-analysis results were stable. Thus, compared with results from single sample groups, the present results are more reliable, representative, and authentic.

However, there are still some limitations to this meta-analysis. First, we only included non-clinical samples of AG and IGD. Studies investigating IGD among individuals diagnosed with behavioral disorders such as AG disorders are few. We believe that serials of data are also crucial for the theoretical and practical areas. Therefore, more research is needed to explore the causal relationships between the two

via experimental design and use clinical samples to test the relationships between IGD and AG. In addition, this study only examined limited moderating variables, such as age and region. Many potential factors that may influence the relationships between IGD and AG should be explored further.

From the perspective of implementing interventions, we found differences in IGD and AG among age subgroups. Compared with primary and secondary school students, college students have more time for Internet games. Moreover, compared with measures such as real-name authentication for minors to prevent IGD, the intervention measures for IGD among college students are not effective. Policymakers should pay attention to the problem of IGD among primary and secondary school students as well as college students. In addition, schools should develop supportive programs to assist individuals who are addicted to IGD and AG. Since individuals who are addicted to Internet games are seeking self-efficacy on the Internet, schools can improve multiple assessment systems for students so that they can find self-worth in real school-life and provide professional services, such as psychological counseling and group counseling activities for individuals with AG to alleviate students' symptoms of IGD and AG.

5. Conclusion

In this study, we found a moderate positive correlation between IGD and AG. That is, people with a higher level of IGD may show more AG. In addition, people with more aggression behaviors may have higher level of IGD. Furthermore, the relationship between IGD and AG is moderated by several variables including region, age, and survey year. The association between IGD and AG is stronger in Asia than in Europe. The correlation coefficient between IGD and AG is in the order of primary school, college, and middle school students. Finally, the relationship between IGD and AG increases with the increase in survey year.

Data availability statement

The original data presented in the study is included within the article. Further inquiries can be directed to the corresponding author.

Ethics statement

Ethical review and approval was not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

SL and YZ designed and supervised the study, and did all statistical analyses. ZW did the literature search and drafted the first version of the article. MX, XW and XM contributed to review and revision. All authors contributed to the article and approved the submitted version.

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Parental control and adolescent internet addiction: the moderating effect of parent-child relationships

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Introduction: The present study investigated how maternal and paternal controls, including behavioral and psychological controls, predict adolescent Internet addiction, as well as the potential moderating effects of adolescent gender and parent-child relationships on the predictions.

Methods: Data were collected from 1,974 Chinese adolescents (age range = 14–22; mean = 16.47; SD = 0.87; 1,099 girls) in Guizhou Province, mainland China in November 2021. Internet addiction was measured using the ten-item Internet Addiction Test developed by Kimberly Young, and Parental control and parent-child relationships were measured by the respective subscales derived from the validated Chinese Parent-Child Subsystem Quality Scale.

Results: Hierarchical regression analyses revealed that after the covariates were statistically controlled, both parents' behavioral controls showed significant negative predictions on adolescent Internet addiction, while their psychological control tended to positively predict Internet addiction among adolescents, although the effect was only marginal. In addition, the impacts of maternal and paternal controls were equal, and such impacts did not vary between sons and daughters. While adolescent gender was not a significant moderator, the parent-child relationship quality significantly moderated the effects of paternal behavioral control, paternal psychological control, and maternal psychological control on adolescents' Internet addiction. Specifically, the prediction of paternal behavioral control was stronger while the effect of paternal and maternal psychological control was weaker among adolescents with a positive father-child relationship than those with a moderate or poor father-child relationship.

Discussion: These findings indicate the protective function of parents' behavioral control and the negative impact of psychological control on the development of adolescent Internet addiction. Further, a positive relationship between the father and the adolescent can strengthen the positive effect of paternal behavioral control and mitigate the negative effects of both parents' psychological controls.

KEYWORDS

psychological control, behavioral control, maternal, paternal, Chinese adolescents

1. Introduction

Nowadays, the use of the Internet has become indispensable. However, Internet addiction, also known as “problematic/pathological Internet use” or “compulsive Internet use”, has emerged as a significant public health concern worldwide. Internet addiction is characterized by preoccupation, desire, impaired control, difficulty to quit, and disregard of negative consequences in different Internet activities, such as online games, social network services, pornographic sites, video collection, and excessive online shopping (1). Although Internet addiction might be multidimensional and characterized by different neurobiological

underpinnings and subtypes, such as cybersexual addiction, information overload, and social network addiction, based on specific addictive behaviors in online settings, it has become increasingly prevalent, especially among adolescents (1, 2).

Adolescents are the most vulnerable to developing Internet addiction in the information age since they face considerable developmental challenges in different domains, including social, emotional, academic, and familial, and often lack effective coping strategies and self-regulation ability (3, 4). Despite the adoption of different assessment tools and criteria on adolescent Internet addiction, a growing body of reports has consistently revealed a relatively high prevalence of Internet addiction among adolescents (5). In Chinese societies, the prevalence rates of Internet addiction among different adolescent samples have been found to be over 20% (6, 7). The issue has drawn much attention because of its close association with other behavioral problems, mental health issues, and social and emotional dysfunctions (4, 8, 9). For instance, a systematic review showed that individuals with Internet addiction are more prone to developing symptoms such as depression, isolation, mental distress, and even suicidal ideations (1).

It was reported that adolescents tend to deal with negative emotions, distress, and frustrations experienced in the real social world through (over)using the Internet to alleviate negative feelings and temporarily escape from real-world troubles (4, 6). As such, understanding the risk and protective social factors that may increase or reduce the likelihood of developing Internet addiction among adolescents is pivotal for effective prevention and intervention. Compared to other social settings, the family represents the most immediate and influential environment where adolescents are socialized. It has been found that family factors, such as parenting practices and relational qualities, significantly impact adolescents' social and behavioral functioning, including Internet addiction (10, 11). Specifically, parental control, as one of the focuses in parenting studies, has been closely associated with Internet addiction in adolescents (12–14).

Barber et al. (15) distinguished between parental behavioral control and psychological control, conceptually clarifying the construct of parental control. Behavioral control refers to parents' efforts to explicitly regulate, monitor, and manage the child's behavior. Moreover, it is considered a protective factor against the child's emotional distress and behavioral problems when such parental supervision is appropriate to the child's age. Prior studies indicated that parental behavioral control is positively associated with adolescents' individual competence, self-discipline, and school performance while negatively associated with adolescents' emotional and behavioral problems (10). In particular, parental behavioral control sets clear rules, helping parents monitor and regulate their children's Internet activities, which can reduce the likelihood of children's misuse (and overuse) of the Internet. Indeed, different empirical studies reported significant relationships between parental behavioral control and adolescents' healthy Internet use (13).

On the other hand, psychological control refers to manipulative, coercive, intrusive, and disrespect strategies used by parents on their children, such as invalidation, emotional blackmail, guilt induction, shaming, unfavorable comparison, or love withdrawal (15, 16). In contrast to behavioral control, which implies due parental authority and discipline, psychological

control is likely to exert undue control over the child's thoughts and feelings, violating the child's self-identity, self-worth, and autonomy. As such, it increases the risk of maladjustment, dysfunctional coping mechanisms, and problematic behaviors, such as Internet addiction (15, 17, 18). Empirically, the deleterious effects of parental psychological control on adolescents' development have been demonstrated across cultures (19, 20), such as excessive Internet use as a dysfunctional means of meeting their psychological needs (6). Indeed, psychological control has displayed a significant positive association with adolescent Internet addiction (11, 13, 21).

Despite the general consensus that parental behavioral control is beneficial for adolescent development, while psychological control is detrimental to a child's healthy functioning, a few unaddressed issues warrant more scholarly attention. Particularly, there is a need to portray a more holistic picture of how parental control is related to adolescent Internet addiction by differentiating paternal and maternal impacts. Historically, fathers are relatively underrepresented in research linking parenting characteristics and adolescent development (22). This might be because mothers, more than fathers, are generally the primary caregivers as reflected by more mother-child daily interactions and mothers' greater emotional support, responsiveness, and overall sense of responsibility toward the child (23). Nevertheless, increasing evidence has revealed that fathers also play an important role in shaping children's development (24, 25).

Most previous studies focused either on maternal parenting or overall parenting characteristics, failing to uncover the distinctions between maternal and paternal impacts on adolescents. Studies which distinguish between fathers' and mothers' roles reported inconclusive findings. Some findings reported stronger maternal impacts (26), some found similar maternal and paternal influences (27, 28), and others revealed stronger paternal impacts (29, 30). With specific reference to adolescent Internet addiction, the results are quite equivocal. For example, in Giles and Price's (31) study, only maternal psychological control showed a positive prediction on adolescents' problematic computer use. Similarly, Shek et al. (11) revealed that only maternal psychological control was a significant predictor of adolescent Internet addiction. However, the study showed that paternal, instead of maternal behavioral control, significantly accounted for variance in adolescents' Internet addiction. In contrast, Lansford et al. (30) found that it was paternal psychological control that exhibited a significant effect on the child's maladjustment; and there was no difference in the effect of paternal and maternal behavioral controls. These seemingly inconsistent findings suggest that the effects of fathers and mothers may differ from each other in different ways when it comes to behavioral and psychological control. However, very few studies have explored this possibility comprehensively. In addition, moderating mechanisms that may alter the way paternal and maternal control affect the child have been largely overlooked.

First, boys and girls may be affected by parental control differently. Adolescent boys may be more vulnerable to negative parenting practices, such as punishment, coercion, and overcontrolling (32, 33). This may be related to different gender role expectations ascribed to boys and girls. While girls are socialized to be more caring and family-oriented, which make them more receptive and compliant to negative parenting, boys are encouraged

to be more independent and assertive, which make them more sensitive to parents' restriction and control (34, 35). This is affirmed by findings that boys are more likely to report unfavorable parenting characteristics (36, 37). Nevertheless, Lansford et al. (30) found that parental control had a stronger influence on externalizing behaviors of girls than on boys. Shek et al. (11) concluded that parental influence on adolescent Internet addiction did not depend on child gender. The inconsistent findings call for more nuanced investigations to have a better understanding of paternal versus maternal impacts on adolescent Internet addiction with reference to child gender.

Second, the quality of parent-child relationship, a vital aspect of family processes (38), may have implications on parental impacts on adolescent Internet addiction. This topic has not been explored in previous studies. Attachment theory (39) suggests that a positive parent-child relationship, characterized by bonding and satisfaction, can provide children with a secure attachment to their parents, creating trust and a secure environment for effective socialization and communication of children's emotions and difficulties. Without it, even adaptive parenting behavior may negatively influence child development (40). A protective parent-child relationship may further enhance the impacts of positive parenting (e.g., behavioral control) while buffering against the negative effects of dysfunctional parenting (e.g., psychological control). Furthermore, emotional security theory (41) provides that positive parent-child relationships foster children's emotional security, enabling them to take others' perspective and appraise their parents' socialization strategies more positively. For instance, they may interpret psychological control as a parental concern or involvement, rather than disrespect or rejection (42). As such, adolescents are more likely to internalize parental control and demands into intrinsic motivation and beliefs, thus experiencing less reluctance and distress (43). Some empirical studies have found that a good relationship with a parent reduced or even reversed the adverse impacts of dysfunctional parenting [e.g., (44–46)].

In addition, the above-mentioned moderating effect may extend to the other parent according to family systems theory, which holds that different subsystems within a family affect each other (47). A positive relationship with one parent may have a spillover effect that evokes acceptance or facilitates the internalization of the other parent's regulations and demands. It is also likely that a good relationship with one parent may compensate for the negative feelings caused by the other parent's unfavorable parenting practices. This type of compensatory process has been tested in terms of heightened interaction with one parent in the absence (or reduction) of another parent's involvement (46). Murray et al. (48) also found that a good father-child relationship buffered against maternal psychological control's negative influence on the child. In summary, theories and findings suggest that the association between one parent's control and adolescent Internet addiction may be moderated by the quality of relationship with either parent. Nevertheless, no research has empirically tested such a proposition.

To address the research gaps in the extant literature, the current study aimed to investigate how maternal and paternal controls (behavioral and psychological control) would be (differently) associated with adolescent Internet addiction, as well as the potential moderating effects of adolescent gender

and parent-child relationships. First, both maternal and paternal behavioral controls were expected to negatively predict adolescent Internet addiction (Hypothesis 1a and Hypothesis 1b, respectively), while both parents' psychological controls would positively predict adolescent Internet addiction (Hypothesis 2a and Hypothesis 2b). The magnitude of maternal and paternal impacts was also compared. Given the previous inconsistent findings, the differences were explored without making any specific hypotheses. Second, the moderating effect of adolescent gender was examined, likewise without making specific hypotheses. Third, based on the discussions on the protective effect of high-quality parent-child relationships, it was hypothesized that the prediction of maternal and paternal behavioral control would be moderated (i.e., enhanced) by better mother-child (Hypothesis 3a and Hypothesis 3b, respectively) and father-child relationships (Hypothesis 3c and Hypothesis 3d, respectively). Meanwhile, the prediction of maternal and paternal psychological controls was expected to be moderated (i.e., mitigated) by better mother-child (Hypothesis 4a and Hypothesis 4b, respectively) and father-child relationships (Hypothesis 4c and Hypothesis 4d, respectively) as well. Figure 1 presents the conceptual framework.

2. Methods

2.1. Participants and procedures

The present study utilized survey data collected in November 2021 from 1,974 adolescents aged 14 to 22 (mean = 16.47, SD = 0.87) in grades 10 and 11 in two high schools in Duyun, Guizhou Province, mainland China. Grade 12 students were not included because they were fully engaged in preparing for the college entrance examination, and the schools did not wish to disrupt their study. All students in the two grades were invited to complete an online survey containing measures on parental factors (e.g., parental control) and developmental outcomes (e.g., Internet addiction) in school computer rooms by class during class hours. The head teacher distributed the survey link to students and reminded them to respond to all questions in the survey based on their own feelings and perceptions. Students read the instructions and information sheet explaining the research objectives and key principles (e.g., anonymity, no-harm, and confidentiality). After the students gave their consent, they were directed to the survey questions. When there were questions left unanswered, remind information directed participants to the unanswered question, allowing them to provide their responses. Thus, the final data set did not have missing values. Following common practice in online survey, two attention checks were included (e.g., "This is an attention check, please choose 'strongly agree'"). Furthermore, each participant's completion time was recorded to help secure valid responses (49). As a result, we excluded 97 cases whose response durations were shorter or longer than three standard deviations from the mean completion time and/or whose answers to either of the attention checks were incorrect, resulting in the final working sample ($N = 1,974$). Among the participants, 55.67% ($n = 1,099$) were girls. Most of them ($n = 1,527$, 77.36%) indicated that their parents were in their first marriage (i.e., intact family). A total of 290 (14.69%) adolescents reported family dependence on governmental

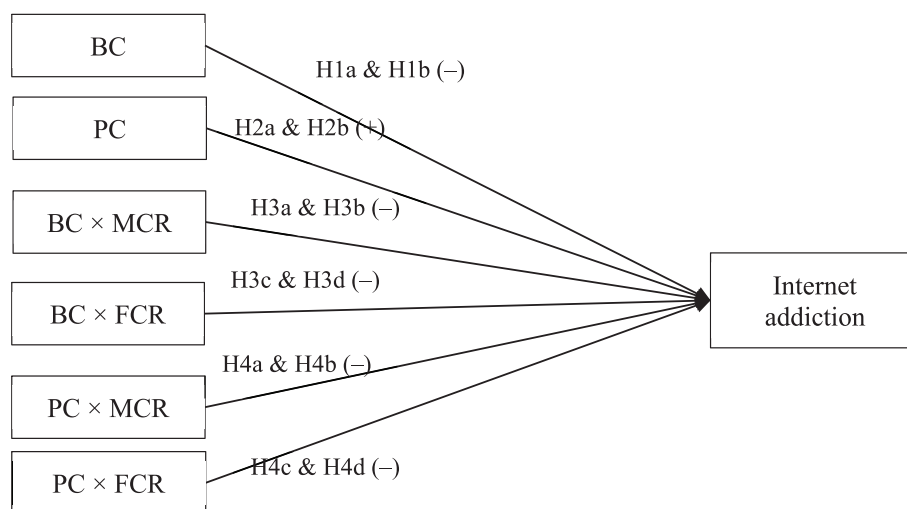


FIGURE 1

The conceptual framework of the association between parental control (behavioral and psychological control) and adolescents' Internet addiction as well as the moderating effect of parent–child relationships. The effect of maternal and paternal control was tested separately. Control variables are not included for parsimony. BC, behavioral control; PC, psychological control; MCR, mother–child relationship; FCR, father–child relationship.

welfare (i.e., poor families). In addition, 485 (24.57%) were the only child (i.e., having no siblings) in the family.

Ethical approval was obtained from the Institutional Review Board (HSEARS20210526004) in the authors' university before data collection. All related parties (i.e., schools, students, and their parents) were informed about the research objectives and principles (e.g., voluntary participation, free withdrawal, anonymity, and confidentiality) and provided their consent.

2.2. Measures

Internet addiction was measured using the ten-item Internet Addiction Test developed by Kimberly Young (50, 51). The Chinese version utilized in the present study was translated and validated by Shek and colleagues (52). The respondents indicated whether (“1 = Yes”; “0 = No”) they had experienced the ten listed typical symptoms of Internet addiction in the past year (e.g., “Have you repeatedly made unsuccessful efforts to control, cut back, or stop Internet use?” and “Do you feel preoccupied with the Internet or online services and think about it while offline?”). The scale demonstrated a unidimensional structure in the present study, and Cronbach's α and McDonald's ω values (i.e., 0.76) indicated adequate internal consistency of the scale (see [Supplementary Table S1](#)). In this study, the Internet Addiction Test score was treated as a continuous variable, consistent with prior research (4, 11). Specifically, adolescents' Internet addiction scores were indexed by the total score across the items, which theoretically range between 0 and 10, with a higher score suggesting a higher level of Internet addiction.

Parental behavioral control and psychological control were measured by the respective subscales derived from the validated Chinese Parent-Child Subsystem Quality Scale that has been frequently used to measure Chinese adolescents' perceptions of

parental factors (53, 54). Each parent's behavioral control was assessed using seven items (e.g., “My father/mother asked me about what I did after school” and “My father/mother actively understands my afterschool activities”), and psychological control was measured using four items (e.g., “My father/mother often wants to change my mind or feelings for things” and “My father/mother values his/her thoughts and overlooks mine”). The adolescents were instructed to rate each parent's behavioral control and psychological control separately using a four-point Likert scale ranging from 1 (i.e., strongly disagree) to 4 (i.e., strongly agree). The two-factor structure (behavioral and psychological controls) fit the data well in both paternal and maternal subscales, and the Cronbach's α and McDonald's ω estimates of all subscales exceeded 0.90 (see [Supplementary Table S1](#)). The average score of each subscale was calculated.

Parent-child relationships were measured using the respective paternal and maternal subscales in the aforementioned Parent-Child Subsystem Quality Scale (53). Each subscale was comprised of six items (e.g., “I proactively share my feelings with my father/mother” and “my father's/mother's discipline of me is beneficial to me”) that were rated on a four-point scale (1 = “strongly disagree” to 4 = “strongly agree”). Cronbach's α s and McDonald's ω s were all above 0.90 in the present study (see [Supplementary Table S1](#)).

Covariates included age, gender, existence of siblings, family economic condition, family intactness, and whether the participants have sibling(s). These covariates have been commonly measured in previous youth studies focusing on parental influence on adolescent development (55). A family's dependence on governmental welfare was considered an indicator of poor family economic condition. For family intactness, whether the first marriage subsists was considered an indicator. Conversely, other marital statuses, such as separated, divorced, or re-married, indicated a non-intact family.

TABLE 1 Hierarchical regression analysis for the predictions of maternal control and its interactions with parent–child relationship on adolescent internet addiction.

Model	Predictor	<i>B</i>	<i>BC 95% CI</i>		<i>SE</i>	<i>Beta</i>	<i>t</i>	<i>Cohen's f²</i>	<i>VIF</i>	<i>F</i> change	<i>R²</i> change
			<i>Lower</i>	<i>Upper</i>							
1	Age	−0.17	−0.28	−0.05	0.06	−0.07	−2.90**	0.004	1.03	2.13^	0.01
	Gender ^a	0.11	−0.09	0.31	0.10	0.02	1.04	0.00	1.02		
	FEC ^b	−0.08	−0.36	0.20	0.14	−0.01	−0.55	0.00	1.04		
	FI ^c	−0.01	−0.24	0.23	0.12	0.00	−0.06	0.00	1.03		
	HS ^d	−0.09	−0.32	0.15	0.12	−0.02	−0.73	0.00	1.07		
2	Age	−0.19	−0.30	−0.08	0.06	−0.07	−3.26**	0.01	1.03	18.52***	0.02
	Gender ^a	0.16	−0.04	0.36	0.10	0.04	1.57	0.00	1.07		
	FEC ^b	−0.03	−0.31	0.25	0.14	−0.01	−0.23	0.00	1.05		
	FI ^c	0.05	−0.19	0.28	0.12	0.01	0.40	0.00	1.04		
	HS ^d	−0.05	−0.29	0.18	0.12	−0.01	−0.45	0.00	1.08		
	MBC	−0.48	−0.64	−0.32	0.08	−0.14	−5.92***	0.02	1.06		
	MPC	0.15	0.04	0.27	0.06	0.06	2.56*	0.003	1.10		
3	Age	−0.18	−0.29	−0.06	0.06	−0.07	−3.08**	0.005	1.03	26.87***	0.03
	Gender ^a	0.11	−0.09	0.31	0.10	0.02	1.06	0.00	1.08		
	FEC ^b	−0.05	−0.33	0.23	0.14	−0.01	−0.35	0.00	1.05		
	FI ^c	0.17	−0.07	0.40	0.12	0.03	1.38	0.00	1.06		
	HS ^d	−0.07	−0.30	0.16	0.12	−0.01	−0.61	0.00	1.08		
	MBC	−0.34	−0.58	−0.10	0.12	−0.10	−2.79**	0.004	2.47		
	MPC	0.14	0.02	0.26	0.06	0.05	2.36*	0.003	1.12		
	MCR	0.31	0.04	0.58	0.14	0.08	2.29*	0.003	2.66		
	FCR	−0.68	−0.86	−0.50	0.09	−0.20	−7.33***	0.03	1.57		
4	Age	−0.17	−0.28	−0.06	0.06	−0.07	−2.97**	0.004	1.04	3.41**	0.01
	Gender ^a	0.08	−0.12	0.28	0.10	0.02	0.76	0.00	1.09		
	FEC ^b	−0.06	−0.34	0.21	0.14	−0.01	−0.44	0.00	1.05		
	FI ^c	0.16	−0.08	0.39	0.12	0.03	1.32	0.00	1.06		
	HS ^d	−0.07	−0.31	0.16	0.12	−0.01	−0.63	0.00	1.08		
	MBC	−0.38	−0.61	−0.14	0.12	−0.11	−3.09**	0.005	2.48		
	MPC	0.20	0.07	0.32	0.06	0.08	3.09	0.00	1.30		
	MCR	0.29	0.02	0.56	0.14	0.08	2.08*	0.002	2.70		
	FCR	−0.66	−0.84	−0.47	0.09	−0.19	−6.99***	0.02	1.60		
	MBC×MCR	−0.03	−0.12	0.06	0.05	−0.02	−0.56	0.00	2.10		
	MBC×FCR	−0.01	−0.12	0.09	0.05	−0.01	−0.24	0.00	1.98		
	MPC×MCR	−0.05	−0.16	0.06	0.05	−0.03	−0.88	0.00	2.00		
	MPC×FCR	−0.10	−0.20	0.01	0.05	−0.05	−1.81^	0.002	1.80		

^a1 = male, 2 = female; ^bFEC = family economic condition (1 = poor, 2 = not poor); ^cFI = family intactness (1 = not intact, 2 = intact); ^dHS = Having siblings (1 = yes, 2 = no); BC, bias corrected; CI, confidence interval; VIF, variance inflation factor; MBC, mothers' behavioral control; MPC, mothers' psychological control; MCR, mother–child relationship; FCR, father–child relationship. ^ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

2.3. Data analysis

Data analyses were performed using SPSS28.0. Reliability analyses were first conducted, followed by descriptive and correlational analyses. Thereafter, several hierarchical regression

analyses were performed to examine the main effects of paternal or maternal control and the moderating effects of child gender and the quality of a parent–child relationship. Covariates were included in the regression models at the first step, maternal/paternal behavioral and psychological control at the second step, and potential

TABLE 2 Hierarchical regression analysis for the predictions of paternal control and its interactions with parent–child relationship on adolescent internet addiction.

Model	Predictor	B	BC 95% CI		SE	Beta	t	Cohen's f^2	VIF	F change	R ² change
			Lower	Upper							
1	Age	−0.17	−0.28	−0.05	0.06	−0.07	−2.90**	0.004	1.03	2.13^	0.01
	Gender ^a	0.11	−0.09	0.31	0.10	0.02	1.04	0.00	1.02		
	FEC ^b	−0.08	−0.36	0.20	0.14	−0.01	−0.55	0.00	1.04		
	FI ^c	−0.01	−0.24	0.23	0.12	0.00	−0.06	0.00	1.03		
	HS ^d	−0.09	−0.32	0.15	0.12	−0.02	−0.73	0.00	1.07		
2	Age	−0.17	−0.29	−0.06	0.06	−0.07	−3.03**	0.005	1.03	36.55***	0.04
	Gender ^a	0.07	−0.13	0.27	0.10	0.02	0.67	0.00	1.09		
	FEC ^b	−0.08	−0.36	0.20	0.14	−0.01	−0.57	0.00	1.04		
	FI ^c	0.15	−0.09	0.38	0.12	0.03	1.23	0.00	1.05		
	HS ^d	−0.07	−0.30	0.16	0.12	−0.01	−0.62	0.00	1.07		
	FBC	−0.64	−0.78	−0.49	0.07	−0.20	−8.54***	0.04	1.11		
	FPC	0.12	0.00	0.24	0.06	0.04	1.88^	0.002	1.15		
3	Age	−0.17	−0.28	−0.06	0.06	−0.07	−2.97**	0.004	1.03	8.23***	0.01
	Gender ^a	0.08	−0.13	0.28	0.10	0.02	0.73	0.00	1.10		
	FEC ^b	−0.08	−0.35	0.20	0.14	−0.01	−0.55	0.00	1.04		
	FI ^c	0.18	−0.05	0.42	0.12	0.03	1.52	0.00	1.06		
	HS ^d	−0.08	−0.31	0.15	0.12	−0.02	−0.68	0.00	1.07		
	FBC	−0.32	−0.54	−0.11	0.11	−0.10	−2.92**	0.004	2.47		
	FPC	0.10	−0.02	0.22	0.06	0.04	1.57	0.00	1.15		
	MCR	0.10	−0.11	0.30	0.10	0.03	0.93	0.00	1.53		
	FCR	−0.49	−0.73	−0.25	0.12	−0.14	−4.01***	0.01	2.70		
4	Age	−0.17	−0.28	−0.06	0.06	−0.07	−2.97**	0.004	1.04	7.38***	0.01
	Gender ^a	0.04	−0.17	0.24	0.10	0.01	0.35	0.00	1.12		
	FEC ^b	−0.09	−0.36	0.19	0.14	−0.01	−0.61	0.00	1.04		
	FI ^c	0.13	−0.10	0.37	0.12	0.03	1.12	0.00	1.07		
	HS ^d	−0.05	−0.28	0.18	0.12	−0.01	−0.39	0.00	1.08		
	FBC	−0.37	−0.59	−0.15	0.11	−0.11	−3.32***	0.01	2.50		
	FPC	0.15	0.02	0.29	0.07	0.06	2.28*	0.003	1.27		
	MCR	0.21	−0.01	0.43	0.11	0.05	1.84	0.00	1.83		
	FCR	−0.62	−0.87	−0.37	0.13	−0.18	−4.86***	0.01	2.99		
	FBC × MCR	0.06	−0.04	0.15	0.05	0.03	1.14	0.00	2.02		
	FBC × FCR	−0.17	−0.26	−0.09	0.04	−0.12	−4.04***	0.01	2.55		
	FPC × MCR	0.00	−0.10	0.10	0.05	0.00	−0.04	0.00	2.42		
	FPC × FCR	−0.12	−0.23	−0.01	0.06	−0.07	−2.21*	0.002	2.71		

^a1 = male, 2 = female; ^bFEC = family economic condition (1 = poor, 2 = not poor); ^cFI = family intactness (1 = not intact, 2 = intact); ^dHS = Having siblings (1 = yes, 2 = no); BC, bias corrected; CI, confidence interval; VIF, variance inflation factor; FBC, fathers' behavioral control; FPC, fathers' psychological control; MCR, mother–child relationship; FCR, father–child relationship. ^ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

moderators (i.e., adolescent gender, parent–child relationships) as well their interactions with parental control at the third and fourth steps, respectively. If adolescent gender would have significant interactive effects with parental control (i.e., moderating effect), simple slope analyses would be further conducted to understand

the predictions of parental control on Internet addiction among boys compared to girls. In addition, the moderating effects of parent–child relationships on adolescent boys and girls would be investigated separately. If adolescent gender would not have significant moderating effects, the two gender groups would be

TABLE 3 Simple slopes of parental control on adolescent internet addiction at different levels of father–child relationship.

Predictor	Father–child relationship	B	BC 95% CI		SE	Beta	t	Cohen's f^2	F change	R ² change
			Lower	Upper						
Maternal psychological control	Low	0.30	−0.08	0.69	0.19	0.11	1.57	0.01	1.67	0.04
	Middle	0.22	0.06	0.38	0.08	0.07	2.72**	0.01	2.94**	0.01
	High	−0.14	−0.31	0.04	0.09	−0.08	−1.52	0.01	0.98	0.02
Paternal behavioral control	Low	0.33	−0.11	0.77	0.22	0.10	1.49	0.01	1.63	0.04
	Middle	−0.57	−0.82	−0.32	0.13	−0.12	−4.54***	0.02	5.16***	0.02
	High	−0.80	−1.20	−0.41	0.20	−0.21	−3.99***	0.04	3.27**	0.05
Paternal psychological control	Low	0.38	0.01	0.75	0.19	0.14	2.04*	0.02	1.97^	0.05
	Middle	0.08	−0.10	0.25	0.09	0.02	0.85	0.001	1.82	0.004
	High	−0.16	−0.34	0.02	0.09	−0.10	−1.70	0.01	1.08	0.02

Control variables are not shown in the table. ^ $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

combined (i.e., using the whole sample) and adolescent gender would be treated as a covariate for analyses. Using bias-corrected bootstrap, 95% confidence intervals were computed for regression coefficients using 2,000 re-samplings.

3. Results

Both parents' behavioral controls and their relationships with adolescents were negatively correlated with adolescent Internet addiction (r ranged between -0.20 and -0.10 , $ps < 0.001$), while parental psychological control showed no significant correlations with Internet addiction (see [Supplementary Table S1](#)). Adolescent gender was not significantly correlated with Internet addiction. Furthermore, adolescent gender did not have significant interactions with maternal or paternal behavioral control or psychological control ($ts = 0.61$ – 1.31 , $ps = 0.19$ – 0.54) on Internet addiction in the regression models. Thus, all formal analyses were based on the whole sample, with gender included in the regressions as one of the covariates.

Results of the hierarchical regression examining the main effects of parental control and its interactions with parent–adolescent relationships are presented in [Table 1](#) (maternal control) and [Table 2](#) (paternal control). For all regressions, the values of variance inflation factor (VIF) were below 3.0. Considering the cutoff point of 5.0 where the issue of multicollinearity becomes a major concern ([56](#)), the current results indicated that multicollinearity was not a major problem in the present study.

As shown in [Table 1](#), after the covariates were statistically controlled, maternal behavioral control negatively predicted adolescent Internet addiction ($\beta = -0.14$, $p < 0.001$, $Cohen's f^2 = 0.02$), while maternal psychological control showed a positive prediction ($\beta = 0.06$, $p < 0.05$, $Cohen's f^2 = 0.003$). Similar to maternal influences, paternal behavioral control also served as a negative predictor of adolescent Internet addiction ($\beta = -0.20$, $p < 0.001$, $Cohen's f^2 = 0.04$), while paternal psychological control

showed a marginally significant positive prediction ($\beta = 0.04$, $p = 0.06$, $Cohen's f^2 = 0.002$, see [Table 2](#)). These results supported Hypotheses 1a, 1b, 2a, and 2b. Further comparisons between regression coefficients revealed that behavioral control showed a stronger effect than psychological control for both maternal influence (absolute value of $z = 6.29$, $p < 0.05$) and paternal influence (absolute value of $z = 7.76$, $p < 0.05$). There were no significant differences between maternal and paternal effects regarding behavioral control (absolute value of $z = 1.46$, $p > 0.05$) or psychological control (absolute value of $z = 0.40$, $p > 0.05$).

As shown in [Table 1](#), father–child relationships showed a marginally significant interaction with maternal psychological control on adolescent Internet addiction ($\beta = -0.05$, $p = 0.07$, $Cohen's f^2 = 0.002$), suggesting that the prediction of maternal psychological control tended to be moderated by father–child relationship (Hypothesis 4c was marginally supported). Analyses of simple slopes (see [Table 3](#)) suggested that maternal psychological control tended to have a positive effect on adolescent Internet addiction when father–child relationship was not high (below +1 SD), while such a positive prediction might be reversed (although it was not significant) when adolescents reported positive father–child relationship (+1 SD). No other moderating effects were identified for maternal control's predictions on adolescent Internet addiction.

Regarding the moderating effects on paternal control's associations with adolescent Internet addiction, while a mother–child relationship did not serve as a significant moderator, a father–child relationship demonstrated significant interactions with both paternal behavioral control ($\beta = -0.12$, $p < 0.001$, $Cohen's f^2 = 0.01$) and psychological control ($\beta = -0.07$, $p < 0.05$, $Cohen's f^2 = 0.001$). Thus, Hypotheses H3d and H4d were supported. Analyses of simple slopes (see [Table 3](#)) revealed that the negative prediction effect of paternal behavioral control on adolescent Internet addiction was stronger for adolescents experiencing positive (+1 SD) father–child relationship quality ($\beta = -0.21$, $p < 0.001$, $Cohen's f^2 = 0.04$), while the effect was not significant among

adolescents reporting negative (-1 SD) father-child relationship quality ($\beta = 0.10$, $p = 0.14$, *Cohen's* $f^2 = 0.01$). Furthermore, paternal psychological control only showed a significant positive effect on adolescent Internet addiction in the condition of negative (-1 SD) father-child relationship ($\beta = 0.14$, $p < 0.05$, *Cohen's* $f^2 = 0.02$). When the father-child relationship was better, the positive prediction of paternal psychological control on adolescent Internet addiction became insignificant. Meanwhile, when it was positive ($+1$ SD), the prediction became negative (although insignificant).

4. Discussion

The first objective of the present study was to examine how parental control predicted adolescents' Internet addiction among Chinese high school students by separating behavioral control and psychological control and differentiating maternal and paternal influences. In general, both maternal and paternal behavioral controls served as protective factors that were negatively associated with adolescent Internet addiction, while both parents' psychological controls were risk factors that increased the likelihood of adolescent Internet addiction. The findings on parental behavioral control are largely consistent with previous conclusions and suggest that behavioral control is one of the positive parenting strategies that help promote healthy behavior among children, including the appropriate use of Internet by setting clear regulations and exercising suitable supervision (13, 14, 57). In addition, the use of behavioral management strategies in parenting seemed more influential than parental psychological control, which confirms previous findings (57, 58).

In contrast, parental psychological control showed marginal positive predictions on adolescent Internet addiction. Similar observations were outlined by Shek and colleagues in their studies on parental influences on the development of Internet addiction among Chinese adolescents in Hong Kong (11, 14). To some extent, these findings echo the previous proposition that psychological control is a dysfunctional parenting practice impairing the child's healthy functioning in different societies (19, 59). Nevertheless, some prior studies reported that parental psychological control insignificantly affects a child's developmental outcomes (54, 55, 57). The weak or insignificant effect of parental psychological control may imply different interpretations of parenting practices in Chinese societies. Specifically, parents' psychological control might be more permissible and acceptable in a collectivistic context, such as in China, as it is used by parents to achieve mainstream socialization goals, in contrast to individualistic contexts where it is perceived negatively (60). Meanwhile, findings based on a global unidimensional measure of psychological control in the present and most prior research may be unable to fully unveil the influence of parental psychological control given the multidimensional nature of psychological control, and different subtypes of psychological control may yield distinct or even contrasted implications (19, 61, 62). Thus, the current findings do not necessarily suggest that the impact of parental psychological control among Chinese adolescents is negligible; however, there is an urgent need to understand operations of individual dimensions in adolescent development.

In the present study, maternal and paternal behavioral and psychological controls showed similar predictive effects on adolescent Internet addiction. Considering that only father-child, not mother-child, relationships functioned as a moderator, it may be assumed that paternal impacts are relatively greater. This observation echoes previous findings that suggest similar paternal and maternal impacts or even greater paternal impact in shaping adolescents' developmental outcomes, including Internet addiction (11, 14, 28, 30). Despite insufficient representation of fathering in previous studies, the role of fathers is significant in the life of adolescents (24, 58). The findings of the present study provide additional empirical evidence for such a claim. Generally, fathers are less devoted to taking care of their children; and adolescents also usually prefer maternal parenting characteristics, as mothers are typically considered interactive, warm, supportive, responsive, responsible, and not controlling (34, 36). Nevertheless, it may be the quality rather than the quantity of a father-child interaction that shapes the child's development. This interpretation is especially relevant in understanding the unique moderating effect of father-child relationships.

Noteworthy, the relationship between a father and an adolescent significantly moderated the effects of maternal psychological control, paternal behavioral control, and paternal psychological control on adolescent Internet addiction. Specifically, the effect of paternal behavioral control was stronger, while the effect of paternal psychological control was weaker among adolescents who reported higher levels of father-child relationship ($+1$ SD) than among those who perceived moderate or poor father-child relationships. This novel finding suggests that a father's good relationship with an adolescent can enhance the protective function of their positive parenting, such as behavioral control, on the adolescent and can mitigate the harmful impact of their dysfunctional parenting, such as psychological control. Furthermore, such a moderating effect even spilled over from father-child dyad to mother-child dyad such that in the present study, a positive father-child relationship mitigated the adverse influence of maternal psychological control on adolescent Internet addiction. The finding supports the expectation of family systems theory which holds that different subsystems within a family affect one another (47). In the current study, the mother-child dyad can be influenced by the father-child dyad. This is an insightful finding given that very limited research effort has been spent in understanding such a spillover effect.

Scholars previously argued that a parent-child relationship lays "the fundamental platform" on which parental control operates [(63), p. 472]. Initially, a good relationship with parents signifies a child's intimate attachment to the parents, making the child more willing to assume parents' good intention and comply with parents' disciplines (57, 64). Additionally, a high-quality parent-adolescent relationship creates a safe family environment for adolescents to communicate and disclose their negative feelings and distress, lessening the likelihood of turning to Internet as an escape (11, 53, 65). Meanwhile, a good relationship with one parent may compensate for the negative feelings adolescents may experience in unfavorable interactions with the other parent (46). While the present findings support the essential functions of a father-child relationship, the moderating effect

of a mother-child relationship was not identified. One possible explanation may be the generally dominant and superior role of fathers in Chinese families, making father-child relationships bear even more salient implications (11, 58). Nevertheless, more studies are needed to further verify and replicate the present findings.

The present study also explored the impact of adolescent gender on Internet addiction, which was found to be insignificant. Despite a considerable number of previous research which reported that boys commonly displayed higher levels of Internet addiction than adolescent girls (4, 11, 57, 66), some studies, including the current one, did not find discrepancies among both genders with regard to Internet addiction (21, 66). The finding that girls tended to report excessive usage of Internet than boys might be due to the possibility that girls have higher problem awareness relative to boys (66). The similar predictive effects of parental control on boys' and girls' Internet addiction found in the present study echo previous findings that yielded comparable parental influences on sons and daughters (11, 12). Nevertheless, there are also findings indicative of distinct parental impacts on boys and girls. For example, Lansford et al. (30) and Shi et al. (67) found stronger impacts of parental factors on developmental outcomes among girls than boys. In contrast, Shek's (68) study indicated that fathering was more influential on sons' (vs. daughters') mental health and behavioral functioning. Given the inconclusive findings, more research must be conducted to explore gender effect.

The present findings have practical implications for developing prevention and intervention programs for adolescent Internet addiction, especially concerning parental involvement and training which were ignored in previous treatment of Internet addiction (69). The significant protective effects of parental behavioral control and the risk effects of parental psychological control on the development of adolescent Internet addiction suggest that parent training programs should highlight the parents' knowledge and skills to monitor and regulate their children's Internet usage actively and correctly. Moreover, given that father-child relationships are likely to serve as a moderator that can strengthen the beneficial effect of fathers' behavioral control and reduce the harmful impact of parental psychological control, elements of promoting children's relationship with fathers (e.g., youth programs building children's communication skills and parent training enhancing paternal involvement in children's daily life) can be meaningfully incorporated in psychological interventions for Internet addiction. Fostering bonding and trust between fathers and children and creating an open and comfortable family environment can be effective strategies to reduce the risk of adolescents' misuse of the Internet and their reliance on the virtual world.

Several limitations of the present study are noted. First, the data on parental factors and adolescent Internet addiction were collected through adolescent self-report, which may inflate shared variance between the predictors and outcomes. However, child self-report of parenting is widely adopted in parenting studies. Many scholars endorse the advantages of this method because the parent report is not necessarily more accurate than the child report, and it is how children interpret (or perceive) parental behaviors that dictate

their adjustment and development (70, 71). In addition, evidence also showed that the associations between parenting and adolescent developmental outcomes were not unduly influenced by common method variance (72). Nevertheless, it will be insightful to adopt multi-informant designs in future studies and further investigate the discrepancies between parent and child reports. Second, a global measure of parental psychological control was utilized, which may hinder the detection of unique effects of subtypes of psychological control (62). It is recommended that future studies adopt a differentiated approach to parental psychological control. Third, the present study involved adolescents in two grades in only two high schools in mainland China. To enhance the generalizability of the findings, the adolescent sample should be expanded to include students from other grades, schools, and Chinese communities (e.g., Hong Kong) in future research. Finally, the current study was cross-sectional and quantitative in nature. To shed light on longitudinal effects of parental control on adolescent Internet addiction, as well as the potential moderating effects of parent-child relationships overtime, and to delineate the in-depth information behind the quantitative findings, it is necessary to employ a mixed-method research design which combines longitudinal quantitative design and qualitative research strategies.

5. Conclusion

The present study contributes to existing literature by differentiating between paternal and maternal behavioral controls and psychological controls and exploring the moderating role of parent-child relationships. The findings suggest that both parents' behavioral controls are protective factors, while their psychological controls are risk factors in the development of adolescent Internet addiction. In addition, the quality of a father-child relationship is likely to moderate the impact of parental control, enhancing the beneficial effects of fathers' behavioral control while reducing the harmful effects of both fathers' and mothers' psychological control. These findings suggest that it is essential to promote positive parenting and improve the relationship between parents and adolescents to prevent adolescent Internet addiction.

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 Institutional Review Board at The Hong Kong Polytechnic University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

XZ designed the research and contributed to all the steps of the work. CD and WB contributed to manuscript drafting. All authors contributed to the article and approved the submitted version.

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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.2023.1190534/full#supplementary-material>

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The association between childhood trauma and adolescent cyberbullying: chain mediating roles of emotional intelligence and online social anxiety

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Objective: This study explored the impact of childhood trauma on adolescent cyberbullying and the mediating roles of emotional intelligence and online social anxiety between them.

Methods: The Childhood Trauma Scale, Emotional Intelligence Scale, and Chinese Brief Version of the Social Media User Social Anxiety Scale and Cyber Bullying Scale were used to assess 1,046 adolescents [boys: 297, girls: 749, average age=15.79years] from four schools in Shandong Province, China. SPSS 25.0 and AMOS 24.0 were used for statistical analysis.

Results: (1) Childhood trauma was positively associated with adolescents' cyberbullying; (2) Emotional intelligence and online social anxiety played partial mediating roles in the relationship between childhood trauma and cyberbullying; (3) Emotional intelligence and online social anxiety played a chain mediating role in the relationship between childhood trauma and cyberbullying.

Conclusion: This study reveals the relationship and mediating mechanisms between childhood trauma and cyberbullying. It provides implications for the theory and prevention of cyberbullying.

KEYWORDS

childhood trauma, emotional intelligence, online social anxiety, cyberbullying, adolescents

1. Introduction

Cyberbullying refers to an assault that an individual or group uses the online media platform to repeatedly and intentionally attack and harm the other individual or group who is unable to protect his/her/themselves (1). In a study on Chinese adolescents, it was found that the incidence of cyberbullying among 5,726 secondary school students over 2 months was 46.8%, of which 19.8% had been bullied, 3.2% had been perpetuating cyberbullying, and 23.8% had been cyberbullied (2). Adolescents are becoming important participants on the Internet owing to online classes. They commit cyberbullying through a variety of channels because of the prevalence and persistence of their Internet use. Due to the anonymous nature of the Internet, adolescents' behavior on the Internet is more aggressive than that at home and school (3), which may seriously affect the physical and mental health of cyberbullying victims. For example, online

bullying can have more negative impacts on the physical, psychological, and academic well-being of victims, and arise more emotional issues related to victimization (4, 5).

Childhood traumatic experiences from the external environment are one of the most important factors in adolescent development (6). Childhood trauma is positively associated with the perpetration of cyberbullying (7), and it is an important determinant of cyberbullying perpetrated by adolescents (8). Studies have shown that childhood trauma and its negative effects are positively associated with pathological use of online applications among adolescents (9), which was, in turn, associated with cyberbullying (10). Concurrently, Sun's study has suggested that adolescents who experienced more traumatic events during childhood were more likely to relieve negative emotions by engaging in cyberbullying during interpersonal conflicts (11). Many studies demonstrated that childhood trauma was negatively correlated with adolescents' emotional intelligence, and individuals with low levels of emotional intelligence may experience more negative emotions, such as anger and aggression, than those with high levels of emotional intelligence, and were more likely to perpetrate cyberbullying (12–15). In parallel, it has been shown that negative life events such as childhood trauma affect individuals' online social anxiety (16, 17), which is also a significant predictor of cyberbullying behavior (18, 19). Most existing research has explored the negative effects of cyberbullying and the relationship between cyberbullying and traditional bullying (20, 21). However, the contributing factors of cyberbullying among adolescents (e.g., childhood trauma and school bullying) have not been well investigated. Therefore, this study explores the roles of two mediating variables—emotional intelligence and online social anxiety—between childhood trauma and adolescent cyberbullying, from the perspective of the general aggression model, thus providing important research support for the reduction and prevention of cyberbullying.

1.1. Theoretical framework

Kowalski argued that the general aggression model provided a valuable theoretical framework for explaining cyberbullying (22). The general aggression model assumes that cyberbullying is influenced by personal and situational factors based on knowledge structures (i.e., scripts and schemas). In addition, it assumes that the cognitive, emotional, and arousal pathways may influence current internal states, and the assessment and decision-making processes may determine behavior, contributing to understand the development of cyberbullying through the input processes of personal and situational factors (23). Inputs from personal and situational factors enter the evaluation and decision-making process through their effects on cognition, emotion, and arousal, meanwhile impulsive behaviors in the proximal process develop into cyberbullying, which ultimately leads to negative distal outcomes for adolescents (e.g., psychological health, social functioning, and behavioral problems) (24). According to the general aggression model, cyberbullying is influenced by a combination of individual and environmental factors. Childhood trauma is one of the environmental factors and emotional intelligence and online social anxiety is individual factors, both of them are valid predictor variables of cyberbullying (25–27). The current study used the general aggression model to explain the relationship between childhood trauma, emotional intelligence, online social anxiety, and adolescent cyberbullying.

1.2. The relationship between childhood trauma and cyberbullying

Childhood trauma is the abuse and neglect committed by a parent or significant other on children before the age of 16 years. Individuals who are unable to cope appropriately with childhood trauma may experience chronic anxiety and subsequent feelings of hopelessness and helplessness (28, 29). Childhood trauma is a manifestation of life stress and includes emotional, physical, and sexual abuse, and emotional and physical neglect (25). Khine and Turk's research has found that childhood experiences can lead to negative emotions in adolescents and influence their onset of behavioral problems in the long term (30, 31). The general aggression model identifies the following environmental factors associated with cyberbullying: parental involvement, school climate, and social interaction (22). Childhood trauma caused by parents or occurred in the school environment is one such environmental factor that serves as a valid predictor variable for cyberbullying (25, 32). It was found that emotional neglect, emotional abuse, physical abuse, sexual abuse, and somatic neglect were all positively associated with the perpetration of cyberbullying (33–36). Accordingly, this study proposes research Hypothesis 1: *childhood trauma has positive influence on adolescent cyberbullying*.

1.3. The mediating role of emotional intelligence

Of the two factors that influence cyberbullying—individual and environmental—individual factors include personal beliefs, attitudes, values, and other stable psychological characteristics. Emotional intelligence is an individual factor and a valid predictor variable of cyberbullying perpetration (22). Emotional intelligence refers to an individual's ability to reason and use emotional information to guide their thinking and actions, including the ability to accurately assess their own and others' emotions, express and regulate emotions adaptively, understand emotions and emotional knowledge, and use emotional information to solve problems (37). Emotional intelligence, as the ability to control one's own emotions and recognize the emotions of others, plays a significant role in adolescents' development (38). However, empirical research has demonstrated that childhood trauma can negatively impact an individual's emotional intelligence (39–41). For example, Jehan found that childhood abuse reduced the ability to use one's own emotions and recognize the emotions of others (42), and thus led to mood disorders (43). Several studies have likewise explored the relationship between childhood trauma and emotional intelligence in different dimensions and found that childhood psychological abuse, psychological neglect, emotional abuse, emotional neglect, and physical abuse all negatively affected emotional intelligence (44–47).

Further, researchers have found that a lack of emotional regulation skills underlies the generation of cyber conflict (26), increasing the probability of aggression. Prior studies (2014) found that emotional intelligence was negatively associated with cyberbullying aggression (13–15). Higher levels of emotional intelligence could be associated with less cyberbullying, and adolescents with lower emotional intelligence scored higher on negative emotions such as aggression, anger, and hostility (12), and exhibited more cyberbullying (26). A

study on university students revealed that bullies had lower emotional intelligence than non-bullies, confirming the relationship between emotional intelligence and cyberbullying (48). Bullies may be characterized as lacking emotional skills in life (49–51); being unable to express, understand, or regulate their emotions; and having lower levels of emotional attention, discrimination, and comprehension of others' emotions (52). This emotional deficit may lead to difficulties in understanding and managing their negative emotions or even identifying them (53). Meanwhile, the adolescent education program developed by Schoeps et al. demonstrated that by training adolescents' emotional intelligence and guiding them to better recognize and regulate their emotions, the probability of cyberbullying can be reduced and adolescents' subjective well-being can be enhanced (54). These existing studies supported the view that the characteristics of emotional intelligence make it one of the strongest protective factors against the emergence of cyberbullying (55, 56). Accordingly, this study proposes research Hypothesis 2: *emotional intelligence mediates the relationship between childhood trauma and adolescent cyberbullying*.

1.4. The mediating role of online social anxiety

Based on the general aggression model, online social anxiety, as one of the internal states of the individual, is also an influential factor in cyberbullying behavior. Individuals with a history of childhood trauma would experience a variety of negative outcomes during their development, including social anxiety (57). Parental rejection from childhood trauma was found to be associated with social anxiety in a community sample of adolescents (58). As the boundaries between online and offline interactions become increasingly blurred, online media interactions can also trigger social anxiety in individuals and even give rise to a new form of anxiety (59), namely, online social anxiety. Online social anxiety refers to the negative interpersonal experience of tension, anxiety, and fear when individuals use social media to interact with others. It encompasses three aspects: interaction anxiety, privacy concerns, and evaluation fears (60). Online social anxiety is considered a form of state anxiety, which is manifested by the perception of possible danger in virtual spaces (61). Some studies have shown that negative life events are significantly and positively correlated with state anxiety, in other words, negative life events could affect individuals' levels of online social anxiety (16, 17).

Chinese scholars have demonstrated that the effects of early negative life events, such as childhood traumatic experiences, would continue into adulthood, hence, maltreated individuals may continue to experience high levels of online social anxiety in social interactions, even after they remove from the previous life circumstances (62–67). In contrast, adolescents under the age of 16 years are temporarily unable to break away from their previous life circumstances and often remember these negative experiences when faced with such circumstances, producing high levels of social anxiety (57). A significantly positive correlation between online social anxiety and cyberbullying has been demonstrated (27). Although online social anxiety has been identified as a significant predictor of cyberbullying, few studies have investigated its longitudinal association with cyberbullying (19, 68). Some studies demonstrated that high levels of online social anxiety were prevalent among cyberbullies (19); as the

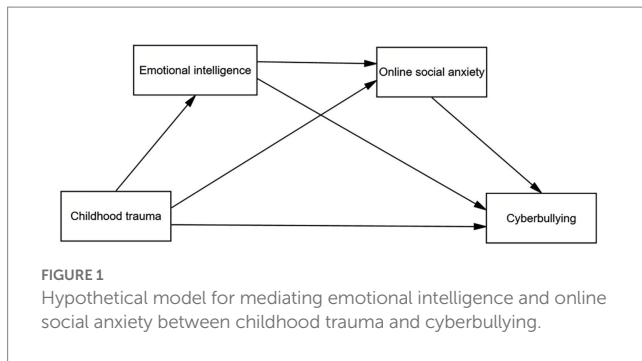
level of online social anxiety increases, the likelihood of aggressive behavior also increases (69). Stable cyberbullying perpetrators have demonstrated higher levels of anxiety than other students (70). This further suggests that anxiety symptoms are a risk factor for cyberbullying. Moreover, anxiety has been suggested as a significant predictor of cyberbullying behavior (18, 19). Therefore, we propose Hypothesis 3: *childhood trauma indirectly influences adolescent cyberbullying behavior through online social anxiety*.

1.5. The chain mediating role of emotional intelligence and online social anxiety

Current research has indicated that adolescent online social anxiety is significantly and negatively related to emotional intelligence (71), implying that emotional intelligence is a significantly negative predictor of social anxiety and increasing emotional intelligence can reduce online social anxiety (72). A significant negative correlation between emotional intelligence and online social anxiety was explored and verified in a non-clinical context (71). Likewise, emotional intelligence was demonstrated to indirectly affect social anxiety by influencing interpersonal adaptation (72). In addition, individuals with high emotional intelligence had higher online interpersonal perceptions and lower online social anxiety when they perceived the dangers of online communities (61). The level of psychological stress that individuals experienced when integrating into different online social groups due to incompatible expectations and demands could further increase individuals' online social anxiety levels (59). Research has shown that emotional intelligence mediates the relationship between gray matter volume in middle temporal gyrus and social anxiety among late adolescents (73). In addition, earlier research found that emotional intelligence explained additional differences in online social anxiety even after adjusting for variables such as anxiety, self-esteem, weight, overall psychological functioning, and demographic characteristics (74–76). Adolescents' emotional intelligence is strongly related to online social anxiety, and increasing emotional intelligence may be an effective way to reduce anxiety. Adolescents who suffered from traumatic childhood experiences had a reduced ability to control their emotions and identify the emotions of others, negatively impacting their emotional intelligence (42). Individuals with lower emotional intelligence could feel uncomfortable in online social interactions due to interpersonal stress, further increasing their levels of online social anxiety (60). As the level of online social anxiety increases, the likelihood of individuals engaging in aggressive behavior also increases (69). Accordingly, we propose Hypothesis 4: *childhood trauma impacts adolescent cyberbullying through a chain mediating effect of emotional intelligence and online social anxiety*.

1.6. Current research

This study examined the mediating roles of emotional intelligence and online social anxiety in the relationship between childhood trauma and cyberbullying using a sample of Chinese adolescents. Figure 1 shows the hypothetical model of the study. By examining the influence of adolescents' childhood trauma on cyberbullying and the mediating roles of emotional intelligence and online social anxiety,



this study expands the current understanding of the mediating mechanism related to cyberbullying. A better understanding provides a strong theoretical basis for effective intervention and reduction of cyberbullying among adolescents.

2. Methods

2.1. Participants and procedures

The survey was conducted using an online web-based questionnaire, and 1,245 students from secondary schools across China were randomly surveyed. The questionnaire comprised 80 items. The survey was conducted with reference to the completion time of 60 respondents in the pre-survey, and those samples with a completion time of less than 180 s in the official questionnaire were judged invalid. The final number of valid questionnaires was 1,046, with 297 (28.39%) boys and 749 (71.61%) girls. The participants' average age was 15.78 years.

This study was approved by the ethics committee of the author's affiliated institution. All students were informed of the study purpose and that the results would be used for research. Written informed consent was obtained from both teachers and parents, and all participants provided verbal informed consent. Subsequently, the students completed the questionnaires in their computer classrooms, guided by trained researchers. The questionnaire included demographic information, scales of childhood trauma, emotional intelligence, online social anxiety, and cyberbullying.

2.2. Measures

2.2.1. Childhood trauma scale

Childhood trauma was measured using the Childhood Trauma Scale developed by Bernstein et al. in 1998 (77). The 28-item scale comprises five factors: emotional abuse (EA) (e.g., "People in my family call me 'stupid' or 'lazy' or 'ugly'"), physical abuse (PA) (e.g., "Someone in my family beat me up so badly I had to go to the hospital."), sexual abuse (SA) (e.g., "Someone has tried to touch me or get me to touch him in a sexual way"), emotional neglect (EN) (e.g., "Someone in my family makes me feel important or special"), and physical neglect (PN) (e.g., "I cannot get enough to eat"). The questionnaire is based on a five-point Likert scale (1 = "never" and 5 = "always"). Questions 10, 16, and 22 of the scale were denial validity scales, which were used to detect underreporting of trauma and were

therefore not scored. The total score of the Childhood Trauma Scale ranged from 25 to 125, with higher scores indicating more severe childhood traumatic experiences. Scores of $PN \geq 10$, $EN \geq 15$, $SA \geq 8$, $PA \geq 10$, and $EA \geq 13$ are considered to indicate having undergone traumatic experiences in childhood (78). The Chinese version of the Childhood Trauma Scale used in this study was translated by Zhao Hao et al. (79). The internal consistency coefficient and construct validity of the Childhood Trauma Scale in this study was 0.623 and χ^2/df (A statistical measure for directly testing the similarity between the sample covariance matrix and the estimated variance matrix) = 4.877, GFI (goodness-of-fit index) = 0.909, CFI (comparative fit index) = 0.883, and RMSEA (root-mean-square error of approximation) = 0.061. These indicate that this scale has good reliability and validity.

2.2.2. Emotional intelligence scale

The Emotional Intelligence Scale, translated by Wang and Law in 2004 (80), was used to assess individuals' levels of emotional intelligence. It comprises 16 items in four dimensions: emotional assessment of self (e.g., "I am a self-motivated person."), emotional assessment of others (e.g., "I can always tell my friends' emotions from their actions."), emotion management (e.g., "I have good control over my emotions."), and emotional use (e.g., "I always set goals for myself and try my best to accomplish them."). The questionnaire is based on a seven-point Likert scale (1 = "strongly disagree" and 7 = "strongly agree"). The total score is the sum of the scores of each question and ranges from 16 to 112. The higher the score, the higher the level of emotional intelligence. Cronbach's alpha for this scale in this study was 0.959 and the fit indicators were χ^2/df = 5.581, GFI = 0.952, CFI = 0.977, and RMSEA = 0.066. These indicate that this scale has good reliability and validity.

2.2.3. Online social anxiety scale

Online Social anxiety was measured using the Chinese version of the Social Media User Anxiety Inventory (81), revised by Chen et al. It comprises 20 items in three dimensions: appraisal fear (e.g., "On social media, I worried that people would find it embarrassing."), privacy concerns (e.g., "When using social media, I often feel uneasy about the possibility of my personal information being made public."), and interaction anxiety (e.g., "I feel uncomfortable talking to people I've just met on social media."). The questionnaire is based on a five-point Likert scale (1 = "not at all" and 5 = "completely"). The total score of the scale was summed across all items, and ranged from 20 to 100, with higher scores indicating higher levels of online social anxiety. Cronbach's alpha of the scale in this study was 0.969, and the fit indicators were χ^2/df = 5.648, GFI = 0.919, CFI = 0.966, and RMSEA = 0.067. These indicate that this scale has good reliability and validity.

2.2.4. Cyberbullying scale

Cyberbullying was measured using the Implementing Cyberbullying Behavior Scale from the Chinese version of the Cyberbullying Scale revised by Youyang (82). This scale measures the frequency of cyberbullying in the preceding 1 year and comprises eight items in three dimensions: cyber verbal bullying (e.g., "When I encounter someone scolding me online, I will also scold them."), anonymity (A) (e.g., "If you see software that allows you to spy on others, you will want to use it and download it."), and cyber fake bullying (e.g., "If I get a dirty picture, I'll find a way to get a dirty

picture of others.”). The questionnaire uses a five-point Likert scale (1 = “*never happens*” and 5 = “*always happens*”). The total score of the scale was summed across all questions and ranged from 8 to 40, with higher scores indicating higher levels of involvement in cyberbullying. Cronbach’s alpha for the scale in this study was 0.848, and the fit indicators were $\chi^2/df=3.734$, GFI=0.991, CFI=0.993, and RMSEA=0.051. These indicate that this scale has good reliability and validity.

2.3. Data analysis

Data were analyzed using SPSS 25.0 and Amos 24.0. First, descriptive statistics and correlation analysis were conducted. Second, structural equation model analysis and bias-corrected percentile Bootstrap method (5,000 repetitions) using the maximum likelihood estimation method of Amos 24.0 statistical software were conducted to evaluate structural models to test for mediating effects (83). Two types of indices were used for the goodness-of-fit: relative and absolute goodness-of-fit indices. The former included the CFI, Tucker-Lewis Coefficient (TLI), and incremental fit index (IFI). The latter comprised χ^2/df , the RMSEA, standardized root mean square residual (SRMR), GFI, and adjusted goodness of fit index (AGFI).

3. Results

3.1. Common method deviation control and testing

The data for this study were all derived from questionnaires, which may be subject to common method bias. According to previous recommendations, a Harman one-way test for common method bias was used (84). The results showed that a total of 13 factors with characteristic roots greater than 1 were extracted from the unrotated factor analysis results, of which the first factor explained 22.209% of the variance, which was below the critical criterion of 40%. This indicated that there was no significant common method bias in this study.

3.2. Descriptive analysis of the variables and their correlation analysis

Table 1 shows that childhood trauma was significantly and positively correlated with cyberbullying and online social anxiety, while significantly and negatively correlated with emotional

intelligence; cyberbullying was significantly and positively correlated with online social anxiety, while significantly and negatively correlated with emotional intelligence; emotional intelligence was significantly and negatively correlated with online social anxiety.

3.3. Correlation coefficients between each dimension of childhood trauma and the three variables

Table 2 shows that each dimension of childhood trauma was significantly correlated with emotional intelligence, online social anxiety, and cyberbullying, among which emotional abuse has the highest correlation with these three variables.

3.4. Structural model

A hypothesis model was constructed by sorting out childhood trauma, emotional intelligence, online social anxiety, and adolescent cyberbullying to obtain a mediation model with the childhood trauma as independent variables and emotional intelligence and online social anxiety as mediating variables that together acted on adolescent cyberbullying. Table 3 shows that the structural model fits well with the fitted values of $\chi^2/df=5.190$, GFI=0.945, CFI=0.954, TLI=0.943, IFI=0.955, AGFI=0.921, SRMR=0.032, and RMSEA=0.065.

3.5. The mediating role of emotional intelligence and online social anxiety in the relationship between childhood trauma and cyberbullying

As shown in Figure 2, the model indicated that childhood trauma was significantly associated with online social anxiety and cyberbullying ($\beta=0.161$, $p<0.01$; $\beta=0.266$, $p<0.01$) and significantly negative associated with emotional intelligence ($\beta=-0.370$, $p<0.01$). Furthermore, emotional intelligence ($\beta=-0.197$, $p<0.01$; $\beta=-0.097$, $p<0.01$) and online social anxiety ($\beta=0.174$, $p<0.01$) were significantly negative and positive correlated with cyberbullying, respectively.

As shown in Table 4, the total effect of childhood trauma on adolescent cyberbullying was 0.791 and the direct effect was 0.614. Emotional intelligence and online social anxiety partially mediated the relationship between childhood trauma and cyberbullying, with a mediating effect of 0.177, accounting for 22.38% of the total effect. The mediating effect comprised three pathways, namely, indirect pathway

TABLE 1 Descriptive statistics for each scale.

Variables	$M \pm SD$	Childhood trauma	Emotional intelligence	Online social anxiety	Cyberbullying
Childhood trauma	33.29 \pm 7.32	1			
Emotional intelligence	85.82 \pm 17.10	-0.375**	1		
Online social anxiety	53.61 \pm 20.01	0.165**	-0.246**	1	
Cyberbullying	11.36 \pm 4.70	0.225**	-0.217**	0.227**	1

** $p<0.01$.

TABLE 2 Correlation coefficients of each dimension of childhood trauma with each variable.

Variables	Childhood trauma	Emotional intelligence	Online social anxiety	Cyberbullying
Emotional abuse	0.732**	−0.257**	0.215**	0.274**
Physical abuse	0.571**	−0.143*	0.086**	0.134**
Sexual abuse	0.436**	−0.144**	0.089**	0.152**
Emotional neglect	0.808**	−0.324**	0.064**	0.111**
Somatic neglect	0.693**	−0.286**	0.127**	0.137**

* $p < 0.05$; ** $p < 0.01$.

TABLE 3 Goodness-of-fit indices for structural models.

Fit index	χ^2/df	SRMR	RMSEA	GFI	AGFI	IFI	CFI	TLI
Recommended value	0–5	<0.080	0–0.080	>0.900	>0.900	>0.900	>0.900	>0.900
Values for this study	5.19	0.032	0.063	0.945	0.921	0.955	0.954	0.943

1: childhood trauma → emotional intelligence → cyberbullying (effect value was 0.083); indirect pathway 2: childhood trauma → online social anxiety → cyberbullying (effect value was 0.065); and indirect pathway 3: childhood trauma → emotional intelligence → online social anxiety → cyberbullying (effect value was 0.029). The effect values for these three pathways accounted for 10.49, 8.22, and 3.37% of the total effect, respectively, and the Bootstrap 95% confidence intervals for all three pathways did not contain 0, indicating that all three mediating effects reached significant levels.

4. Discussion

This study aimed to explore the influence of childhood trauma on adolescent cyberbullying and examine the chain mediating role of individual factors (emotional intelligence and online social anxiety) in this relationship from the perspective of the general aggression model. The study revealed the generation and development of cyberbullying among adolescents in a more comprehensive way, and the results of the study can provide a reference for empirical studies of cyberbullying worldwide. Therefore, it is beneficial to explain the causes of cyberbullying in the era of big data and provide a new perspective for intervening in adolescent cyberbullying and promote the healthy physical and psychological development of adolescents.

4.1. The relationship between childhood trauma and cyberbullying

The study demonstrated a significant positive association between childhood trauma and cyberbullying, confirming Hypothesis 1. It also found that all dimensions of childhood trauma were positively associated with cyberbullying, again confirming that childhood trauma is a significant predictor of cyberbullying (33–36). Childhood trauma is the ultimate source of the “cycle of violence” (85), and children who have experienced trauma are more likely to perpetrate violence. Adolescents who are traumatized in their family are more likely to engage in aggressive behavior than those who are not traumatized (86) for two reasons. First, adolescents who have experienced childhood trauma often grow up feeling fearful, angry,

lonely, rejected, denied, and afraid of failure, as well as having many uncertainties and not knowing appropriate ways to express their negative emotions. These would increase their likelihood of perpetrating cyberbullying (33). Second, adolescents who have experienced childhood trauma tend to isolate themselves, perceive everyone as insecure, and have low self-trust, self-esteem, and sense of value, but have high expectations of themselves. This contradiction makes them vulnerable to high frequency of aggressive behaviors (4), and their aggressive behaviors are more often manifested through cyberbullying. Therefore, adolescents with more severe childhood trauma are more likely to commit cyberbullying.

4.2. Analysis of chain mediating effects of emotional intelligence and online social anxiety

A chain mediation model was developed to account for the relationship between childhood trauma and cyberbullying and to elaborate on the mechanisms by which emotional intelligence and online social anxiety play mediating roles between the two.

First, the study showed that emotional intelligence mediated the relationship between childhood trauma and adolescent cyberbullying, which confirmed Hypothesis 2. The present study showed that childhood trauma was negatively associated with emotional intelligence. This is consistent with previous findings that adolescents with higher levels of childhood trauma have lower emotional intelligence (39, 40). Adolescents who have experienced abuse or trauma are emotionally controlled by others, and they tend to express their emotions passively and negatively, communicate poorly, and easily interpret the emotions of others as potential danger signals and become hostile to others (87). Traumatic childhood experiences can inhibit individuals from learning how to properly use and understand emotional information from life events, while these negative life events can lead to a reduction in the volume of the corpus callosum in the brain dedicated to a range of higher cognitive, emotional, and other information transfer functions, further impairing the development of emotional competence (88). Simultaneously, the current research showed that emotional intelligence was negatively associated with cyberbullying, with individuals of lower emotional

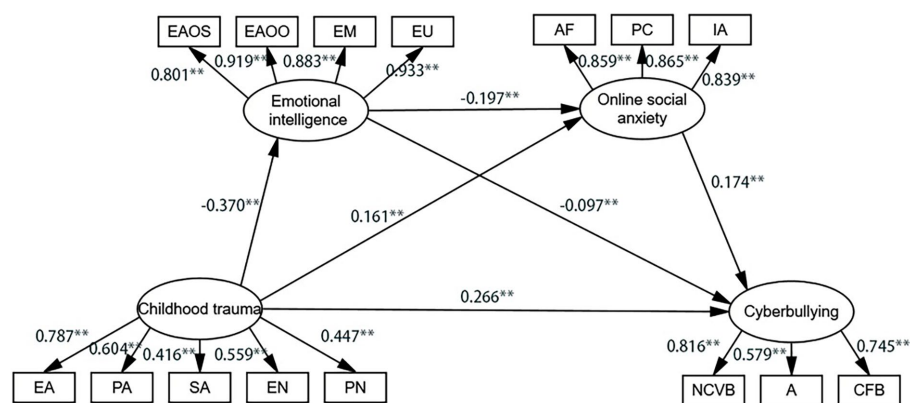


FIGURE 2 Multiple mediation model. Path values are the path coefficients (Standardization coefficient). ** $p < 0.01$.

TABLE 4 Bootstrap analysis of the mediating effects test.

	Paths	Effect value	Boot SE	BootLLCI	BootULCI
Direct effect	Childhood Trauma → Cyberbullying	0.614	0.158	0.334	0.953
Indirect effects	Ind1	0.083	0.04	0.01	0.167
	Ind2	0.065	0.022	0.031	0.117
	Ind3	0.029	0.009	0.015	0.051
Total effect	Childhood Trauma → Cyberbullying	0.791	0.155	0.518	1.129

Ind1: Childhood trauma → emotional intelligence → cyberbullying.
Ind2: Childhood trauma → online social anxiety → cyberbullying.
Ind3: Childhood trauma → emotional intelligence → online emotional intelligence → cyberbullying.

intelligence exhibiting more aggressive behavior, which was also consistent with previous research (13, 15). The more traumatized an individual is in childhood, the worse their emotional experience and expression will be, and the more problems they will have with emotional communication and interpersonal interactions in their lives, resulting in lower emotional intelligence (89). Adolescents with low emotional intelligence are unable to regulate their emotions and recognize the emotions of others. They tend to be rejected or discouraged by others in interpersonal interactions, thus causing them to have more negative emotions and increasing their likelihood of cyberbullying. In contrast, adolescents with higher emotional intelligence have higher levels of emotional understanding, and emotional regulation, and empathy (90), and they have fewer negative emotions (15, 91), reducing their involvement in cyberbullying. Thus, cyberbullying can be considered an aggressive response to negative emotions triggered by low emotional intelligence caused by childhood trauma.

Second, the study showed that online social anxiety played a mediating role in the relationship between childhood trauma and adolescent cyberbullying, verifying Hypothesis 3. Childhood trauma was significantly and positively associated with online social anxiety, which was consistent with previous studies (57). Childhood trauma can negatively affect individuals' mental health, such as triggering negative emotions (e.g., sadness, shame, and fear), leading to their withdrawn personalities and dislike of interacting with others, causing them to show more avoidance and withdrawal behaviors in later

interpersonal interactions, increasing the risk of online social anxiety. Simultaneously, online social anxiety was positively associated with adolescent cyberbullying, and as the level of online social anxiety increases, the likelihood of aggressive behavior among individuals increases as well (69). It can exacerbate their psychological and interpersonal stress. Furthermore, the more severe the rejection and disregard from peers, the more severe the anxiety and irritability generated when interacting with people. These negative emotional experiences can exacerbate the aggressiveness of individuals, who, owing to the anonymity and unrestricted nature of the Internet, have the potential to increase their connectivity through social media, thus increasing the likelihood that they will perpetrate cyberbullying (92).

Finally, the study revealed the chain mediation of emotional intelligence and online social anxiety in the relationship between childhood trauma and adolescent cyberbullying, verifying Hypothesis 4. Individuals with high emotional intelligence are able to detect others' emotions in a timely and accurate manner in their daily social activities, form more positive interactions with others, and effectively deal with stress from social interactions. Individuals with low emotional intelligence are unable to develop good interpersonal interactions and online interpersonal perceptions (72), resulting in high levels of online social anxiety, further increasing the occurrence of cyberbullying. Moreover, adolescents with high emotional intelligence are able to reasonably assess their emotions when facing stress and difficulties in life, find appropriate ways to adjust when negative emotions are formed, and reduce their negative emotions (93).

4.3. Implications and limitations

This study explored the fundamental causes and mechanisms of adolescent cyberbullying based on the general aggression model, providing an important theoretical basis for preventing and reducing adolescent cyberbullying. This study explored the internal mechanisms by which childhood trauma influenced cyberbullying and identified three important pathways of action: childhood trauma → emotional intelligence → cyberbullying; childhood trauma → online social anxiety → cyberbullying; and childhood trauma → emotional intelligence → online social anxiety → cyberbullying. These results theoretically extend the general aggression model to explore cyberbullying behaviors and influencing factors in adolescent groups, not only explaining the influence of childhood trauma on cyberbullying, but also the mechanism of action by which this influence arises. Additionally, these findings provide insight into the prevention of cyberbullying, enrich the existing research literature, and provide implications for future research. Practically, this study suggests that cyberbullying can be indirectly prevented and controlled by increasing emotional intelligence and reducing the online social anxiety level of individuals who have experienced childhood trauma. As an early negative life event, childhood trauma can considerably damage children's physical and mental health, and its negative effects may not subside for decades. Accordingly, this should be taken seriously by families, schools, and society. In the process of adolescents' growth, parents should pay attention to their daily lives, encourage adolescents to express their emotions correctly, and consciously guide adolescents to feel emotional changes and express their emotional experiences in a timely manner through language and writing. Schools should actively conduct programs to improve students' emotional intelligence and reduce their online social anxiety, guide adolescents to better understand and regulate their emotions, establish a sense of proper emotion management, reduce their online social anxiety level, and train good online social skills to improve their interpersonal relationships, improve adolescents' mental health, and further reduce and avoid the occurrence of cyberbullying. At present, domestic and international research on the relationship between childhood trauma and youth cyberbullying is incomplete. Most existing research explores the negative effects of cyberbullying and the relationship between cyberbullying and traditional bullying (20, 21). But the underlying causes of the occurrence of cyberbullying in adolescents (e.g., the effects of childhood trauma such as parental abuse and bullying in school) are not well researched. And the pathways of how childhood trauma influences cyberbullying need to be further explored in future empirical studies.

This study has some limitations. First, it is a cross-sectional study with varying degrees of recall bias, which cannot fully explain the causal relationship between childhood trauma, emotional intelligence, online social anxiety, and cyberbullying. Future research should adopt a longitudinal approach, which would allow researchers to better assess the cyberbullying behavior of participants who have suffered traumatic childhood experiences, in addition to intervening and ameliorating cyberbullying behaviors caused by such trauma. Second, the data for each variable were obtained from participants' self-reports. As such, participants may have experienced social approval effect, leading to questionnaire responses that do not fully and accurately reflect their true situations. To further improve the results and validity of this study, we recommend that future studies use objective measurement tools or add other sources of information to assess these variables. Similarly, the CR (Construct Reliability)

and AVE (Average Variance Extracted) data in this study's indicators are not satisfactory and should be improved in future studies. Finally, the study sample only included Chinese secondary school students, whose academic interests inclined to the liberal arts, with more girls than boys; consequently, the findings may not generalize to other cultural contexts. However, as the variables assessed in this study may be expected to show similar relationships in other populations, future studies should expand the scope to include other cultural contexts.

5. Conclusion

The findings of this study can be summarized as follows. (1) Childhood trauma, emotional intelligence, and online social anxiety are significantly correlated with each other; childhood trauma and online social anxiety are significantly positively correlated with cyberbullying and emotional intelligence are significantly negatively correlated with cyberbullying. (2) Childhood trauma influences cyberbullying indirectly through emotional intelligence and online social anxiety. (3) Childhood trauma can affect cyberbullying directly or through the "emotional intelligence – online social anxiety" mediating chain.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Biomedical Ethics Committee of Qufu Normal University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article.

Author contributions

GC: methodology, validation, investigation, resources, data management, written review and editing, project management, funding acquisition, and supervision. XW: conceptualization, methodologies, software, investigation, writing, and editing. JL: software, writing, revision, and editing. XL: formal analysis, written review, editing, and supervision. All authors in this study contributed to the article and approved the submitted version.

Conflict of interest

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

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Excessive use of electronic devices among children and adolescents is associated with musculoskeletal symptoms, visual symptoms, psychosocial health, and quality of life: a cross-sectional study

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Objective: Electronic devices have become an indispensable part of our daily lives. The frequency and duration of device use in children and adolescents have increased drastically over the years and the study of its negative musculoskeletal, visual and psychosocial health impacts is necessary.

Materials and methods: This cross-sectional study aimed to evaluate the associations between electronic device use and the prevalence and severity of musculoskeletal symptoms, visual symptoms, psychosocial health, and quality of life in children and adolescents studying at primary and secondary schools. Data were collected through confidential online and paper-and-pencil questionnaires. Primary 4–5 and Secondary 1–4 students were recruited from 3 schools in Hong Kong. Demographics, frequency and duration of electronic device use, frequencies of musculoskeletal symptoms, visual symptoms, psychosocial health, and quality of life outcomes were measured.

Results: 1,058 children and adolescents aged 9–17 years participated. Sixty-one percent and 78% of all students spent more than 2 h per day using electronic devices during school days and weekend/holidays, respectively. Extended electronic device use was associated with increased prevalence and severity of musculoskeletal symptoms (p 's=0.28–0.33, P 's<0.001), visual symptoms (p 's=0.33–0.35, P 's<0.001), and poorer device use-related psychosocial health (p 's=0.38–0.47, P 's<0.001). Secondary school students reported greater device use and severity of symptoms than primary school students.

Conclusion: Excessive electronic device use was associated with increased prevalence and severity of physical and psychosocial symptoms, and such use is more prevalent in adolescents when compared to the children. The findings have important health implications for children and adolescents, suggesting that early intervention is needed to reduce the risk of developing device use-related disorders.

KEYWORDS

children and adolescents, electronic device, musculoskeletal symptoms, visual symptoms, psychosocial health, quality of life

Introduction

Many youths use electronic devices daily. Over 95% of adolescents aged 13–16 years owned their smartphones in 2018 globally and this figure has increased by 22% since 2014 (1). Electronic devices include smartphones, tablets, computers, and game consoles (2). These devices are used for social networking, studying, and entertainment. Most recently, perhaps due to the need to limit face-to-face activities because of Covid-19, the primary reason to use electronic devices has been shifting from entertainment to education, especially in economically privileged countries where e-learning has been incorporated into the school policy (3). As a result, the frequency and duration of electronic device use in adolescents has increased dramatically (4).

A growing body of research has also been showing that the extended electronic device use is associated with numerous musculoskeletal symptoms including neck/shoulder pain, lower back pain, and arm discomfort (2, 3, 5–9). These symptoms are known to be associated with reduced physical activity, increased medication use, and school absence in adolescents (10–12).

Associations between the use of electronic devices and visual problems have also been reported (2, 3, 7, 13). Prolonged and frequent use of visual display units can lead to the development of Computer Vision Syndrome (CVS), which is associated with a set of specific symptoms, including burning sensations, dryness, and tearing in the eyes (14). Other CVS symptoms include asthenopia, blurry vision, eye strain, and slow focusing, which are linked to the fatigue of visual system components (14).

The psychosocial health issues brought by the excessive use of electronic devices are also beginning to receive more attention. Evidence, most of which has been conducted in Western countries, has shown that the excessive device use is associated with sleep disruption, parental relationship problems, school performance problems, mental health problems, and daytime fatigue (2, 15–19).

Most children in the United States, United Kingdom, Singapore, China, Norway, Japan, and many other countries, exceed the 2-h daily screen time limit recommended by the American Academy of Pediatrics and the HKSAR Department of Health (7, 17, 18, 20–22). In the United Kingdom, over 60% of adolescents aged 15 spent more than 2 h watching TV per day (23). Similar figures were reported in a Norwegian study conducted in 2013 (20). Granich and colleagues found that up to 87% of Australian children used screen-based media for over 2 h on a daily basis (24). It has also been reported that American children spent 6.43 h on screen-based media per day, on average (21). Notably, research has shown that symptoms which develop in childhood and adolescence due to extended device use predispose those individuals to a higher risk of musculoskeletal and visual system disorders in adulthood (6, 25).

Although knowledge about the negative impact of device use in youth is gradually increasing, there remains a great deal that is not yet known. For example, very few studies have examined the role of

device use on psychosocial health; even fewer have compared children in primary school and adolescents in secondary school regarding the prevalence and severity of symptoms associated with electronic device use.

Given these considerations, the objectives of the current study were to increase our understanding of the nature and impact of device use in children and adolescents. To address these objectives, we sought to estimate: (1) the overall amount of electronic device use and symptom severity in samples of primary and secondary school students, and if they differed as a function of age/education level, and (2) the associations between device use and the prevalence and severity of a variety of symptoms and quality of life domains. We hypothesized that (1) more than 50% of the both study samples would report an average daily use greater than or equal to the recommended maximum of 2 h/day, (2) older participants would report more electronic device use and symptom severity than younger participants, and (3) more electronic device use would be associated with higher prevalence and severity of symptoms, and lower device-related psychosocial health and quality of life.

Methods

Study design

A cross-sectional study design was adopted. Data on the demographics, electronic device use of the adolescent participants, point prevalence and severity (expressed in terms of frequency and intensity) of musculoskeletal symptoms, visual symptoms, psychosocial health, and quality of life were measured and collected by questionnaire.

Recruitment procedure and data collection

Study participants were recruited via the convenience sampling, from schools in Hong Kong that: (1) were registered under the Hong Kong Education Bureau, (2) offered Primary 5–6 or Secondary 1–4 education (i.e., grades 5–10), and (3) did not focus on serving children with special needs. The inclusion criteria for the student participants are being: (1) a student in grades 5–10, (2) able to read and write Chinese or English, and (3) able to complete an online or hard copy version of the study questionnaire without assistance.

Consent for their child's and adolescent's participation was obtained from the parents of the student participants who were <18 years old. Signed consent for all of the student participants was obtained before the distribution of the questionnaire. The data were collected from September 2019 to March 2020. A teacher in each school distributed a hard copy of the questionnaires or provided a link for participants to complete the questionnaire online, after explaining the purpose, process and ethical issues of the study. It took 10–15 min to complete the study measures as reported by the teachers.

A total of 1,152 students from one primary and two secondary schools were approached. One thousand and seventy-three of these students and their parents consented to participate in the study, and 1,058 students (response rate of 92%) completed the study questionnaires.

Ethical consideration and confidentiality

The study was approved by the Human Subjects Ethics Sub-Committee of the Hong Kong Polytechnic University (Reference Number: HSEARS20180604002). The completed questionnaires were stored in a secured place or encrypted storage and were not used for any purpose other than the study.

Measures

Demographic variables and intensity of device use

The questionnaire asked participants to provide information regarding their demographics (i.e., age, sex, and class year), and to indicate the average daily hours of electronic device use on school days and on holidays.

Musculoskeletal-related symptoms

Participants were also asked to indicate the presence, frequency, and intensity of four musculoskeletal-related symptoms during and/or after using electronic devices ([Supplementary material](#)). Presence and frequency were assessed using a 4-point Likert scale (0 = “Never: The symptom/condition does not occur at all”; 1 = “Occasionally: Sporadic episodes or at most 1 time/week”; 2 = “Frequent: 2–3 times/weeks”; 3 = “Always: Almost every day/week”). For symptoms that were rated as being present, their intensity was assessed using a 3-point categorical scale (Mild = “You can feel the symptom, but it does not bother you”; Moderate = “The symptoms are bothering you and a break might be needed due to the symptom”; Severe = “The symptom bothers you so much that a treatment either by yourself or medical professionals is needed”). The four musculoskeletal symptoms assessed were pain or aches, stiffness, or tiredness in the (1) neck, (2) shoulder, and (3) back regions, and (4) feelings of pins and needles or numbness in the upper limbs.

Vision-related symptoms

The presence, frequency and intensity of nine visual symptoms were also assessed, using the same questions used to assess musculoskeletal symptoms. The symptoms chosen for assessment were based on those associated with CVS ([14](#)), and included eye dryness, eye burning, eye itching, tearing, eye redness, eye pain, blurred vision, difficulty focusing for near vision, and double vision.

Psychosocial health related to device use

We also asked participants to indicate the presence and frequency with which: (1) they used an electronic device longer than originally intended, (2) others complained about the participant's electronic device use, (3) they attended school, (4) they perceived a negative impact of electronic device use on school performance, (5) they experienced sleep disturbance, and (6) were emotionally upset when not using electronic devices.

Musculoskeletal discomfort index, eye discomfort index, and device-related psychosocial health index

The responses to the questions assessing symptoms or problems in each of the above three domains were used to compute scores representing: (1) a Musculoskeletal Discomfort Index (MDI), (2) an Eye Discomfort Index (EDI), and (3) a Device-Related Psychosocial Health Index (DRPHI). A respondent was classified as being symptomatic if they had a value of >0 on the respective index (i.e., reported at least one episode of at least one symptom), and asymptomatic if they answered “Never” in response to all of questions related to a symptom domain. The internal consistency (Cronbach's alpha) of the MDI, EDI and DRPHI in the current sample were 0.90, 0.85, and 0.79, respectively, indicating adequate to excellent reliability.

Quality of life

Questions assessing additional health and quality of life domains that could potentially be impacted by device use were also assessed, and included: (1) change in refractive error over the last 12 months, (2) days spent on exercise per week excluding PE lessons, (3) average daily sleep duration, (4) quality of relationship with family and frequency of having disagreement with family members in the past 12 months, and (5) academic performance.

Data analysis

Descriptive statistics were computed for all study variables for descriptive purposes. Study hypothesis 1 was tested by examining the percentage of respondents across both samples who reported using an electronic device for more than 2 h/day. We then conducted a series of Mann–Whitney tests to test the second study hypothesis; that is, to evaluate the differences in the time spent on electronic device during weekdays and weekend/holidays (the cumulative usage time/day collected in the questionnaire were in ordinal scale), musculoskeletal symptoms, visual symptoms, and psychosocial health between primary and secondary school students. We also computed Spearman's rank coefficients between the participants' education level (i.e., class year) and the average number of hours of device use. Finally, we tested the third study hypothesis by computing a series of Spearman's rank correlation coefficients between the average number of hours of electronic device use and the study criterion variables (i.e., MDI, EDI and DRPHI scores, and responses to the five questions assessing quality of life domains). A value of *p* of less than 0.05 was considered to be statistically significant. Data were analyzed using IBM SPSS Statistics (Version 26.0, Armonk, NY, IBM Corp.).

Results

Demographics

[Table 1](#) presents the descriptive information about the study sample. As can be seen the mean age (SD) of the entire study sample was 12.83 years (SD, 1.76; range, 9 to 17). Fifty-one percent were male and 50% were female (sums to >100% due to rounding error).

Device use on school days, weekends and holidays

Thirty-eight percent and 69% of the primary and secondary school participants used an electronic device ≥ 2 h/day. The average hours of electronic device use in secondary school students was significantly greater than in primary school students ($U=62,384$, $p<0.001$). Meanwhile, 44% and 90% of primary school and secondary students reported that they used an electronic device ≥ 2 h/day during weekends and holidays, respectively. The average duration of electronic device use was significantly higher in the secondary school group during weekends and holidays ($U=31,994$, $p<0.001$). Class year was positively and significantly associated with the average time spent on electronic devices during school days ($\rho=0.36$, $p<0.001$) and during weekends and school holidays ($\rho=0.49$, $p<0.001$; Figure 1).

TABLE 1 Demographics including age and class years of the participants ($n=1,058$).

Age in years	Range	Mean (SD)
	9–17	12.83 (1.76)
Class year	n (%)	
Primary 5	129 (12.19%)	
Primary 6	119 (11.25%)	
Secondary 1	237 (22.40%)	
Secondary 2	191 (18.05%)	
Secondary 3	192 (18.15%)	
Secondary 4	190 (17.96%)	

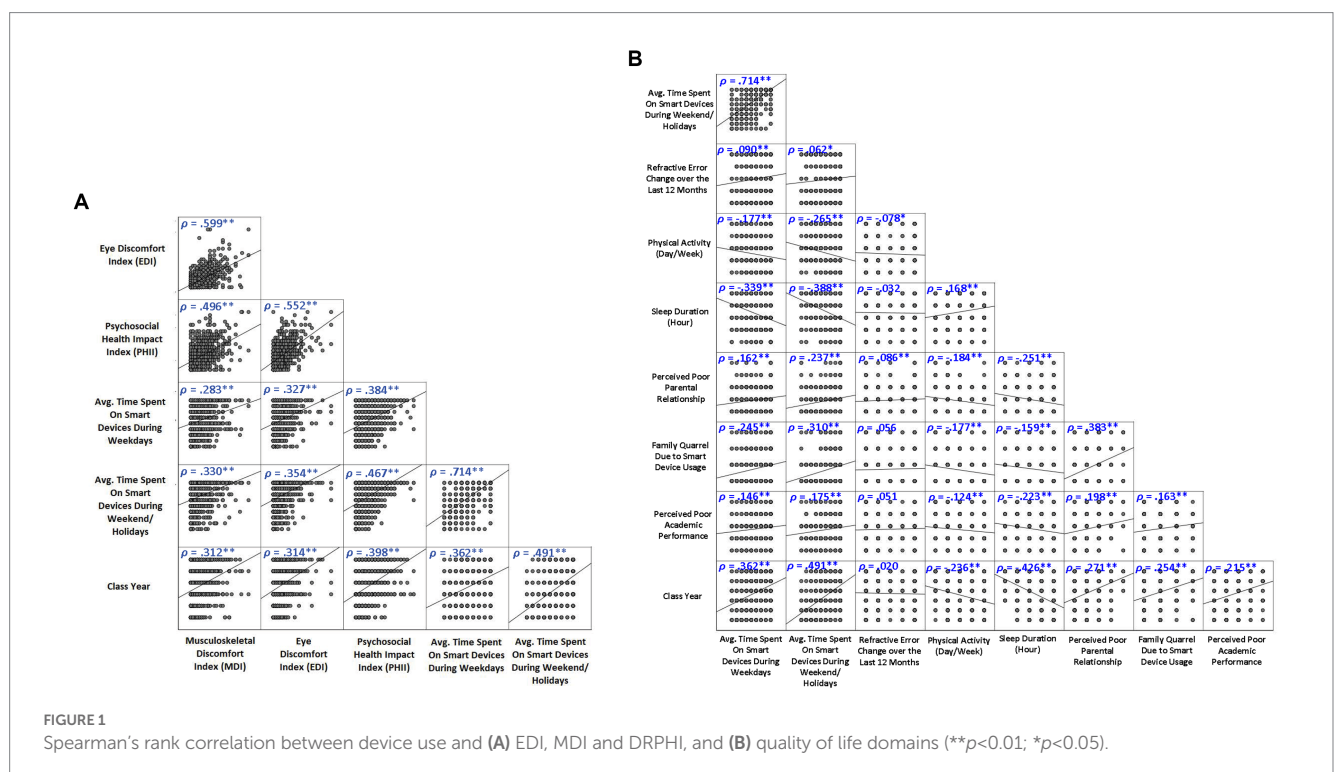
Prevalence and frequency of musculoskeletal and visual symptoms

Overall, 24% to 53% and 12% to 55% of participants endorsed having musculoskeletal and visual symptoms during and/or after electronic device use, respectively; the majority reported occasional symptoms (Figures 2, 3). More than half of the participants reported having at least occasional neck pain or aches (53%), neck tiredness (52%), and eye dryness (55%). For low back pain or ache, eye tearing, and eye dryness, the number of secondary school students endorsing the symptoms at least 2–3 times per week was around 5 to 8 times higher than primary school students.

The percentage of participants reporting musculoskeletal and visual symptoms was approximately 1.8 to 3.0 times higher in secondary school students than primary school students. The frequencies of all musculoskeletal and visual symptoms were significantly higher in secondary school participants (U 's=65,838 to 91,109, P 's<0.001; Figures 2, 3). The MDI and EDI were both significantly and positively correlated with the class year (ρ 's = 0.31 and 0.31; P 's<0.001; Figure 1).

Intensity of musculoskeletal and visual symptoms

In terms of intensity, 67% to 72% and 65% to 77% of all symptomatic respondents experienced mild musculoskeletal and visual symptoms, respectively (Figures 2, 3). Eighteen percent to 22%, and 11% to 21% of participants reported moderate musculoskeletal and visual symptoms. The percentage dropped to 1% to 3% and 1% to 5% for severe musculoskeletal and visual symptoms. The proportion of secondary school students endorsing moderate visual symptoms (13% to 24%) was higher than that of primary school students (0%). Statistically significant



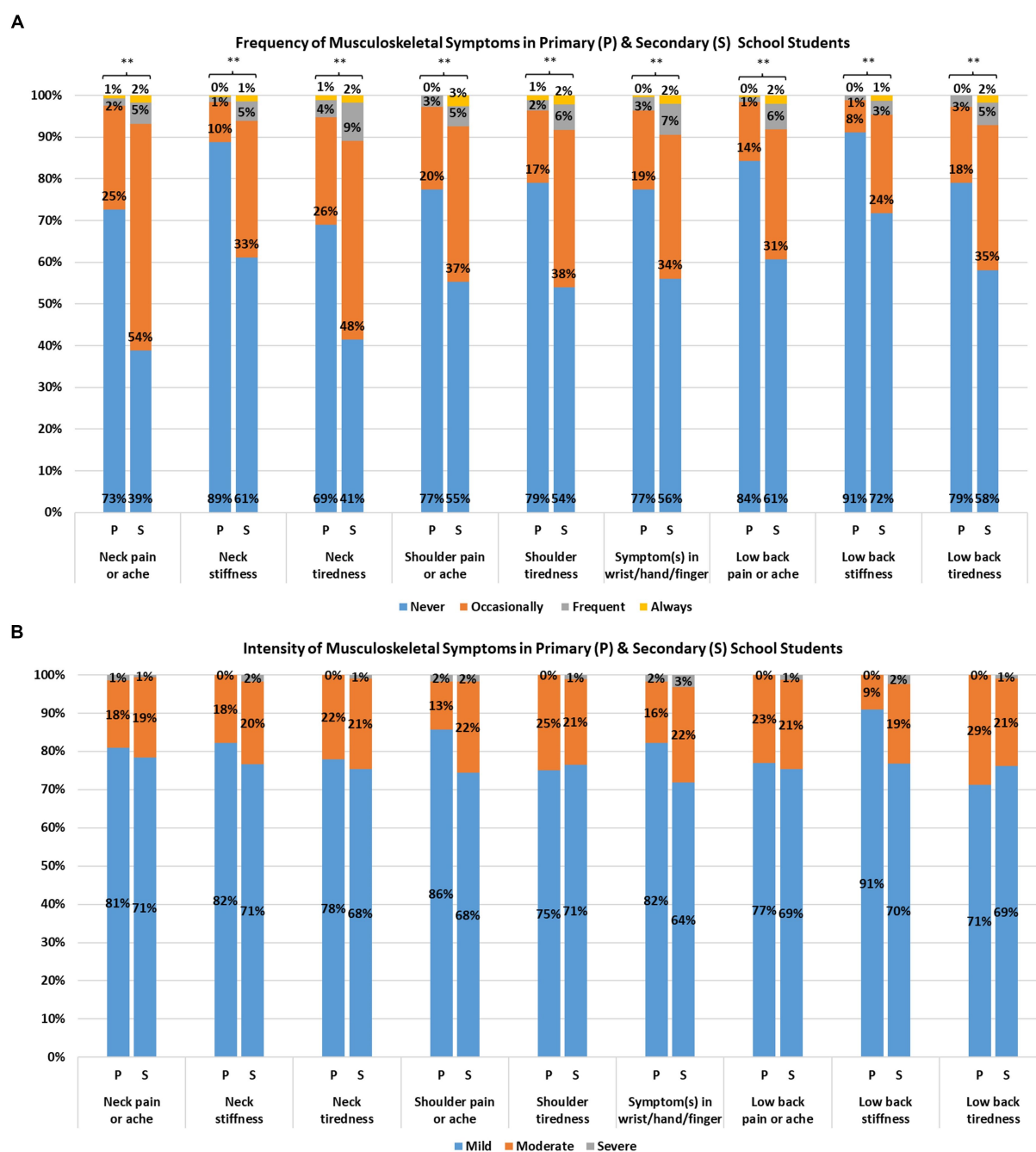


FIGURE 2

Self-reported frequency (A) and intensity (B) of musculoskeletal symptoms from primary and secondary school students (** $p < 0.01$).

differences between primary and secondary school students in intensity were found for eye dryness ($U = 10,492$, $p < 0.001$), eye burning ($U = 514$, $p = 0.03$), eye itching ($U = 2,256$, $p = 0.002$), tearing ($U = 5,194$, $p = 0.02$), eye redness ($U = 3,089$, $p = 0.04$) and blurred vision ($U = 2,340$, $p = 0.03$), but not in the remaining visual and musculoskeletal symptoms.

Device-related psychosocial health

More than half of all respondents reported having at least some problems with electronic device use for 3 out of the 6 domains (Figure 4). This included reporting that (1) they used electronic devices

longer than intended (72%), (2) others complained to them about the time spent on electronic devices (68%), and (3) sleep disruption due to late night usage of electronic devices (55%). The percentage of secondary school students endorsing these issues were generally higher (1.2 to 8.9 times) than that of primary school students. The frequencies of all 6 device-related issues were significantly higher in secondary school population (U 's = 54,182 to 90,839, P 's < 0.001 ; see Figure 4). A significant relationship was found between class year and DRPHI ($\rho = 0.40$, $p < 0.001$; see Figure 1). Finally, the rates of secondary school students endorsing device-related issues at least 2 to 3 times weekly (i.e., frequent or always) were about 3 to 9 times higher than that of primary school students. Significant relationships were found between the time spent

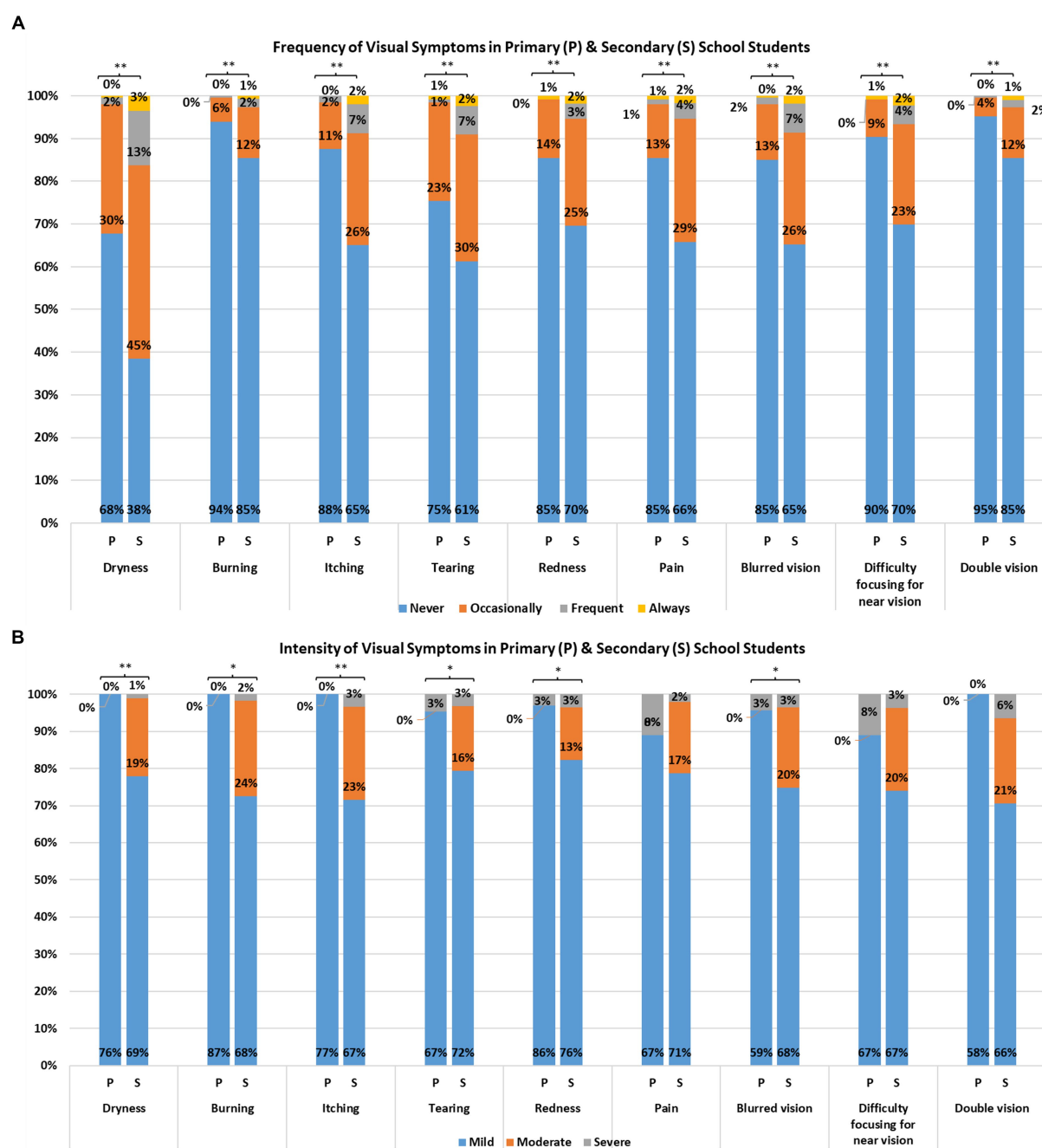


FIGURE 3

Self-reported frequency (A) and intensity (B) of visual symptoms from primary and secondary school students (** $p < 0.01$; * $p < 0.05$).

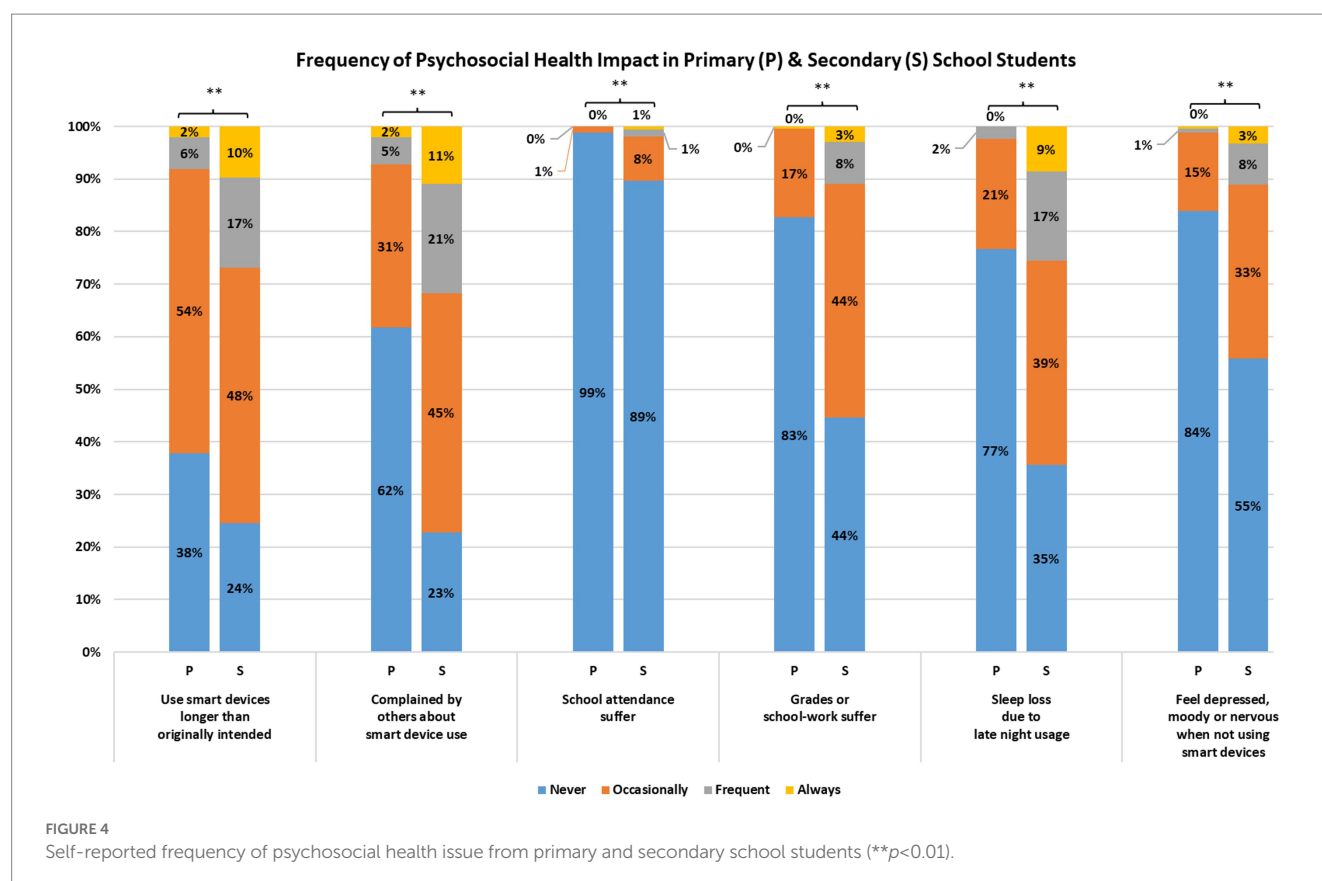
on electronic device and reduced physical activity and sleep duration, and poorer family relationship and academic performance (Figure 1).

Discussion

Electronic device use among children and adolescents

The study findings are consistent with prior research reporting high use of electronic devices among children and adolescents (2, 7, 17, 18).

Alarming, 18% and 36% of the study participants spent 4 h per day or more using electronic devices during school days and weekends/holidays, respectively, which is more than twice the time limit suggested by the American Academy of Pediatrics (22, 26). In addition, the findings showed that the secondary school students reported a greater use of electronic devices than did the primary school students. These findings highlight the critical importance of early intervention targeted at primary school or even earlier to minimize the development of electronic device habits in youth. While restraining the device use time on recreational purpose among the youth is crucial, it would not be practical to limit the use of electronic devices for learning since the computer-assisted



instruction has become indispensable in the modern education. Musculoskeletal Symptoms.

The highest prevalence of musculoskeletal symptom reported was in the neck region, including neck pain or aches (53%) and neck tiredness (52%). Sustained cervical muscle contraction, flexed neck posture due to lower display placement, lack of postural breaks and poor ergonomic workstation setup are all potential mechanisms of musculoskeletal symptoms among device users (2, 7, 27–29). The higher severity of musculoskeletal symptoms in older participants could potentially be due to the extended use of electronic devices, increased access to smartphones, and greater academic burden that requires electronic device use for learning (3, 7, 18). One of the more straightforward ways to alleviate such physical impact might be to encourage frequent breaks in between classes (e.g., 5–10 min postural break for each hour of device use) or after-class activities to help vary the posture (8, 22). Adding more time for physical education, including activities that target musculoskeletal health, is another possible strategy that could be encouraged by teachers. These additional interval breaks or physical education class can reduce the risk of having physical symptoms, without sacrificing academic performance (30, 31).

The present findings revealed that greater musculoskeletal symptoms were associated with higher class year and more device use. These findings are consistent with those from a study conducted by Toh and colleagues, who found that the odds of musculoskeletal symptoms increases 4 to 7% for every hour of daily smartphone use (7). The portability offered by handheld electronic devices is a double-edged sword that allows for multitasking on the one hand, but may

also result in people using the device for longer than intended on the other.

Visual symptoms

Similar to musculoskeletal symptoms, greater electronic device use was significantly associated with visual symptoms. One possible cause for the development and maintenance of these symptoms is the reduced blink rate and increased number of incomplete blinks that can occur with device use. Low blink rates increase corneal exposure to air, causing tear evaporation, and resulting in dry eyes and ocular irritation (2, 7, 13, 32). Also, constant accommodation is required when focusing on a screen, with a short viewing distance, especially when the screen is small as it is in a smartphone (2). This can result in eye strains, causing asthenopia. The blue light emitted from the screen is also thought to be damaging the cornea and retina, and contribute to eye fatigue (13, 14, 32).

The severity of visual symptoms was also significantly and positively associated with class year. One of the possible explanations of this finding is the longer duration of electronic device use by older children for different purposes (3, 7). These findings also point to the critical need to develop and then implement more effective strategies as school routines (e.g., 20–20–20 eye resting rule and adding 2 h/day of outdoor activities) for reducing screen use in children and adolescents, especially given the potential long-term negative consequences of eye problems that develop during childhood (4, 33).

Device-related psychosocial health

Our results clearly show that screen use had a negative association with device-related psychosocial health. The association between prolonged device use and negative relationships with parents was evident, leading to quarrels which can contribute adverse parent-child relationship (2, 22). The disagreement between parents and children might be further amplified by mood swings due to poor sleep quality, because of late night use of electronic device (34). The findings suggest the need for parental education and training in how they can effectively help their children limit device use, while maintaining positive interactions.

Parents could potentially help by providing greater structure for their children's device use, by allowing device use when children meet specific goals, such as accomplishing household chores or achieving satisfactory grades. Moreover, parents could also act as a positive role model for their children in terms of healthy use of electronic devices.

Sleep deprivation was another key psychosocial health issue. The length of sleep was inversely related to the time spent on electronic devices; a finding consistent with a study conducted by Parent and colleagues (35). Exposure to video games prior to sleep and viewing a bright screen while engaging in tasks linked to emotional responding (e.g., gaming or social media), could increase an adolescent's psychophysiological arousal, thus interfering with sleep (36–38). Furthermore, the blue light emitted by the screens on many devices can interfere with melatonin production and the circadian rhythm (16, 38). Insufficient sleep, which is detrimental to the adolescent's growth and development, is also associated with fatigue and poor academic performance (16, 39). Again, these findings point to the need to educate parents regarding effective strategies they can use to help limit the negative effects of device use on their children's sleep quality.

Limitations

This study has a number of limitations that should be considered when interpreting the results. First, the study sample did not include senior secondary school students (Secondary 5 and 6), because they were busy preparing for the local public exam for university entry. Additional research with a large sample size that include senior secondary school students to be recruited through random sampling method would be needed to promote the generalizability of the findings. Second, given that the data are cross-sectional, it is not possible to test for and draw conclusions about causal associations among the study variables. However, it seems unlikely that potential musculoskeletal and visual problems use would have a causal impact on the higher device usage among the children and adolescents.

Conclusion

Despite the study's limitations, the findings provide new information regarding the frequency of device use in children and adolescents, as well as the associations between this use and age, musculoskeletal problems, eye problems, and psychosocial health. It would appear that the traditional parenting approach to simply limit

children's access to electronic devices is not practical (3, 22). Additional efforts to provide children, adolescents, parents, and teachers with education about the healthy use of electronic devices (e.g., ergonomics, interval postural and visual breaks, physical activity) appears needed. Early intervention may be necessary to target the prolonged and improper use of electronic device among children at early age, to prevent the long-term health consequences, particularly when computer-assisted learning has become increasingly popular and common. This can be achieved by implementing the health education and screening, and large-scale longitudinal studies with the collaborative effort between various stakeholders, which include the youth, their parents and their schools as well as the public health policies to be set by the government.

Data availability statement

The original contributions presented in the study are included in the article/[Supplementary material](#), further inquiries can be directed to the corresponding author.

Ethics statement

The studies involving human participants were reviewed and approved by Institutional Research Board, Hong Kong Polytechnic University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

ST, GC, AL, AS, PP, K-CY, JC, and MJ: conception or design of the work, acquisition, analysis, or interpretation of data for the work, drafting and revising of the work, and approval of publication of the content. All authors contributed to the article and approved the submitted version.

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Conflict of interest

K-CY was employed by Hong Kong Evangelical Church Social Service Limited, Hong Kong.

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

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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpubh.2023.1178769/full#supplementary-material>

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Effects of smartphone addiction on cognitive function and physical activity in middle-school children: a cross-sectional study

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Introduction: This study aimed to investigate the effects of smartphone addiction on cognitive function and physical activity in middle-school children.

Methods: A population of 196 children (boys and girls) from middle schools were recruited for this study with an average age of 12.99 ± 0.81 years, a height of 153.86 ± 6.50 meters, a weight of 48.07 ± 7.31 kilograms, and a body mass index of 20.22 ± 2.08 kg/m². Smartphone addiction was determined using Arabic versions of the Smartphone Addiction Scale-Short Version, and physical activity levels were assessed by a physical activity questionnaire for older children. The working memory and selective attention domains of cognitive function were evaluated using a laptop screen's digital version of the memory automaticity and Flanker tasks, respectively. A one-way MANOVA was conducted to determine the differences in working memory between the smartphone-addicted and non-addicted groups. The relationship between smartphone addiction and physical activity was analyzed using Pearson's chi-squared test.

Results: The cognitive function-attention domain accuracy component showed a statistically significant difference between the groups, with a p -value of 0.05). The reaction time between smartphone-addicted and non-addicted children showed no statistically significant difference ($p = 0.817$). The relationship between smartphone addiction and physical activity was statistically significant ($p < 0.001$).

Discussion: The interaction effects between physical activity and smartphone addiction on reaction times showed statistically insignificant ($p = 0.25$) differences, showing that physical activity's effect on reaction times did not depend on smartphone addiction levels. The non-addicted children had significantly higher physical activity levels than the addicted children, indicating that smartphone addiction reduced physical activity.

KEYWORDS

smartphone addiction, children, cognitive function, physical activity, memory, attention

Introduction

Due to the rapid expansion of the Internet and other technological breakthroughs, it is anticipated that the number of mobile phone users will continue to increase annually. Smartphones are considered the most prevalent electronic device among children. A study discovered that, compared to tablets and laptops, smartphones were the most commonly used gadgets among children, with a mean weekly usage of 28.5 h (Alobaid et al., 2018). This

could be considered a strong indicator of children's rapid exposure to smartphone usage. Children currently rely on smartphones for many things, including attending online classes, communicating, playing games, shopping, and watching entertaining videos. Children also use smartphones instead of books for reading and studying (Nasution, 2021). Smartphones can be used to access educational resources, stay connected with friends and family, and learn new skills. This way of life significantly impacts children's day-to-day activities, and they become too attached to their smartphones, which might lead to addiction (Nasution, 2021).

Smartphones are characterized by rapid technological development and increasing prevalence due to their flexibility in function, portability, and purpose of use. There have been numerous unresolved queries concerning the effects of smartphone addiction on cognitive functions. Moreover, the conclusive evidence is still limited and conflicted, especially among children (Wilmer et al., 2017). Studies found that students exposed to smartphones or receiving more mobile phone calls or text messages showed shorter response times and were less accurate on working memory tasks (Abramson et al., 2009; Thomas et al., 2010). In contrast, Wasmuth et al. (2022) did not find a relation between general smartphone use (time/frequency) and inattention (Wasmuth et al., 2022). Neurophysiological studies report that heavy smartphone use is associated with attention, number processing, and right prefrontal cortex excitability impairments. However, there were no significant differences in working memory or inhibitory control (Hadar et al., 2017). While there is no conclusive evidence that smartphones harm a child's cognitive function, some studies have produced alarming results. Paulus et al. investigated the association between screen media activity behavior, brain structure, and cognitive function changes. They found a significant association between changes in the structural characteristics of the brain and time spent on screens, including smartphones. They also found that some activities related to screening media and brain structures are associated with worse cognitive performance, while others are associated with better cognitive performance. It suggests that screen media activity is not "good or bad for the brain" (Paulus et al., 2019). More research is required to determine whether or not the use of electronic devices impacts cognitive function, particularly by children.

Physical activity and smartphone addiction are regarded as two health-related independent variables, yet they are interconnected (Wu et al., 2017; Li et al., 2020). The prolonged use of smartphones can affect physical health by reducing participation in physical activities, which leads to a decrease in muscle mass and an increase in fat mass, both of which are associated with bad health consequences (Kim et al., 2015). A recent review of the association between smartphone addiction and participation in sports and physical activity among children and adolescents revealed that an increase in smartphone addiction decreases physical activity and sports performance (Azam et al., 2020). Although a few studies indicate no significant association between smartphone addiction and physical activities, this is not the case in general (Buctot et al., 2020). Numerous studies have shown that the prolonged use of smartphones is highly correlated with sedentary lifestyles and physical inactivity (Fennell et al., 2019; Xiang et al., 2020).

Physical activity can raise dopamine levels and receptor binding rates in the human body, which helps reduce addictive behaviors (Roberts et al., 2012). Fewer smartphone users would be extremely likely to experience better cognitive functions in their daily lives (Hadlington, 2015). According to a cross-sectional study, physical activity is directly connected with enhanced cognitive function (Hamer and Chida, 2008). A systematic review described that regular physical activity has the most protective effect against cognitive decline (Blondell et al., 2014). Therefore, this raises questions regarding the potential effects of smartphone addiction on cognitive function and physical activity in children. However, no systematic research has examined the effects of smartphone addiction on cognitive function and physical activity in Saudi Arabian children aged 12–14 years. This study aimed to assess the effect of smartphone addiction on cognitive function and physical activity among middle-school children. Another aim of the study was to compare the cognitive function and physical activity of addicted and non-addicted middle-school children.

Materials and methods

Study design and setting

A cross-sectional study with an analytic and descriptive structure was adopted to conduct this study. The research was conducted between December 2021 and February 2022 at eight public and private middle schools for boys and girls in the Eastern Province of Saudi Arabia (Dammam, Al Khobar, and Dhahran).

Sample size

The sample size was calculated based on the Raosoft online calculator at (<http://www.raosoft.com/samplesize.html>). The confidence level was 95%, and the significance level was 5%, with an expected prevalence of 87% of mobile phone usage among children and adolescents in Saudi Arabia (DOCOMO GN, 2011). The recommended sample size is 173. With a 10% dropout rate, the estimated total sample required for the current study was 200 children.

Ethics approval

Ethics approval was obtained from the Institute Review Board of the University of Imam Abdulrahman Bin Faisal (IRB-PCS-2021-03-369). Each participant signs a written informed consent form prior to participating in the study.

Selection of schools and participants

The study samples were drawn from eight schools chosen randomly from a list of schools using a lottery method. Following contact with the selected schools to conduct the study, a random selection of children from these schools was also made using

random number generator software (<https://www.random.org/>). All selected children were healthy school-going children of Saudi nationality and both sexes, with an age range of 12–14 years in the Gregorian calendar. Children with anemia, diabetes mellitus, hypertension, obesity, asthma, or seizures, a history of vision or hearing problems, anxiety, attention deficits, sleep disorders, a history of smoking, neuromuscular disorders, and physical disabilities and those who are unable to pay attention to the researcher's instructions or read and understand the questionnaires and testing procedures were excluded from the study. Based on their SAS-SV scores, the children were categorized into the smartphone-addicted and non-addicted groups.

Procedure

The researcher went to the selected schools and explained the study process to the principals. The principals gave their written informed consent once they were informed about the research process and agreed to the data being collected at their schools. Afterward, children were randomly selected. All participants were recruited from intermediate-school grades 7, 8, and 9, with equal numbers of students from each grade to control confounding factors. Then, the research process was explained to them in detail. Once they agreed, they signed the consent form and participated in the study. Finally, the parents gave their consent through the WhatsApp application. With the help of the school principal, the researcher was provided with a copy of the student's medical history report, and all participants were assessed for eligibility. Out of 200 children, 196 met the criteria for inclusion. The researcher then started collecting their demographic information, such as their gender, age, level of education, height, weight, and body mass index (BMI). Smartphone-related information was collected, such as the duration of smartphone use per day and the number of years the children owned the smartphones. These details were recorded for each child on a separate data entry sheet. The height was measured (in meters) using a measuring tape, and the digital weighing scale was used to measure the weight (in kilograms). The body mass index (BMI) was calculated by dividing weight in kilograms by height in meters squared. After obtaining the demographic data, each child participated in three evaluations: the first evaluation was for assessing smartphone addiction levels, the second for evaluating cognitive function, and the third for measuring physical activity levels. The smartphone addiction and physical activity levels were assessed by self-assessment paper-based questionnaires using the Arabic versions of the Smartphone Addiction Scale-Short Version and the Physical Activity Questionnaire for older children, respectively. The working memory and selective attention domains of cognitive function were evaluated using a laptop screen's digital version of the memory automaticity and Flanker tasks, respectively. During the test procedure, the children were individually seated in a quiet room with the investigator in front of a laptop screen. The investigator explained the tasks to the children, and once they were ready and understood the task's procedure, they started the actual tasks.

The memory automaticity task was used to assess working memory. This task requires remembering whether or not a letter

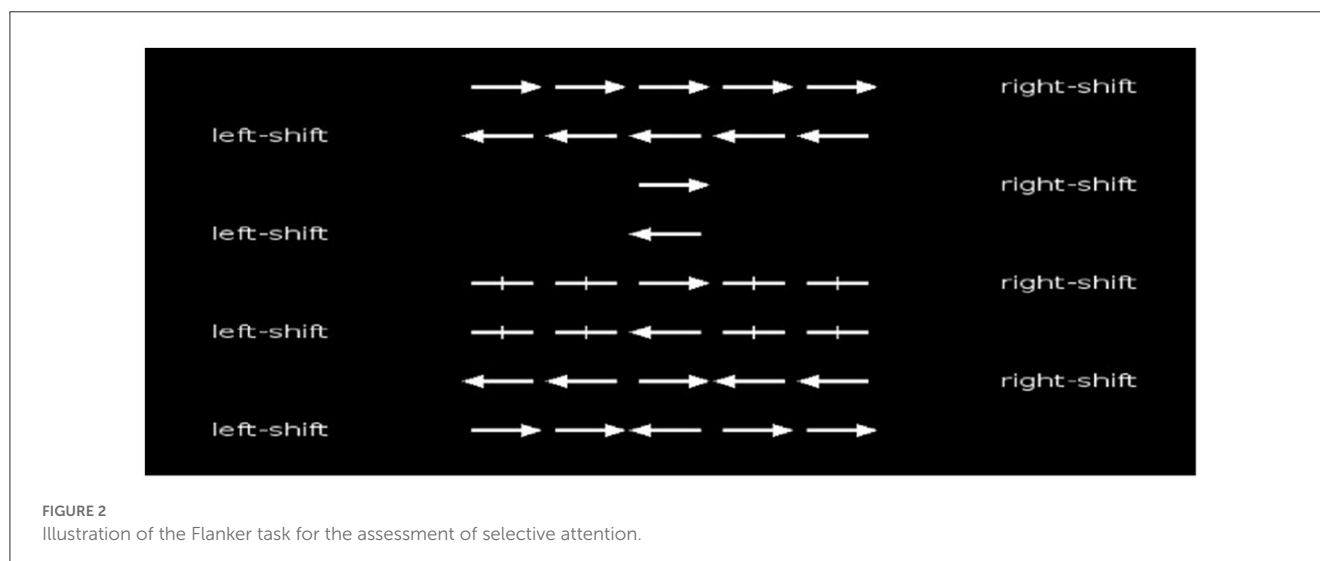
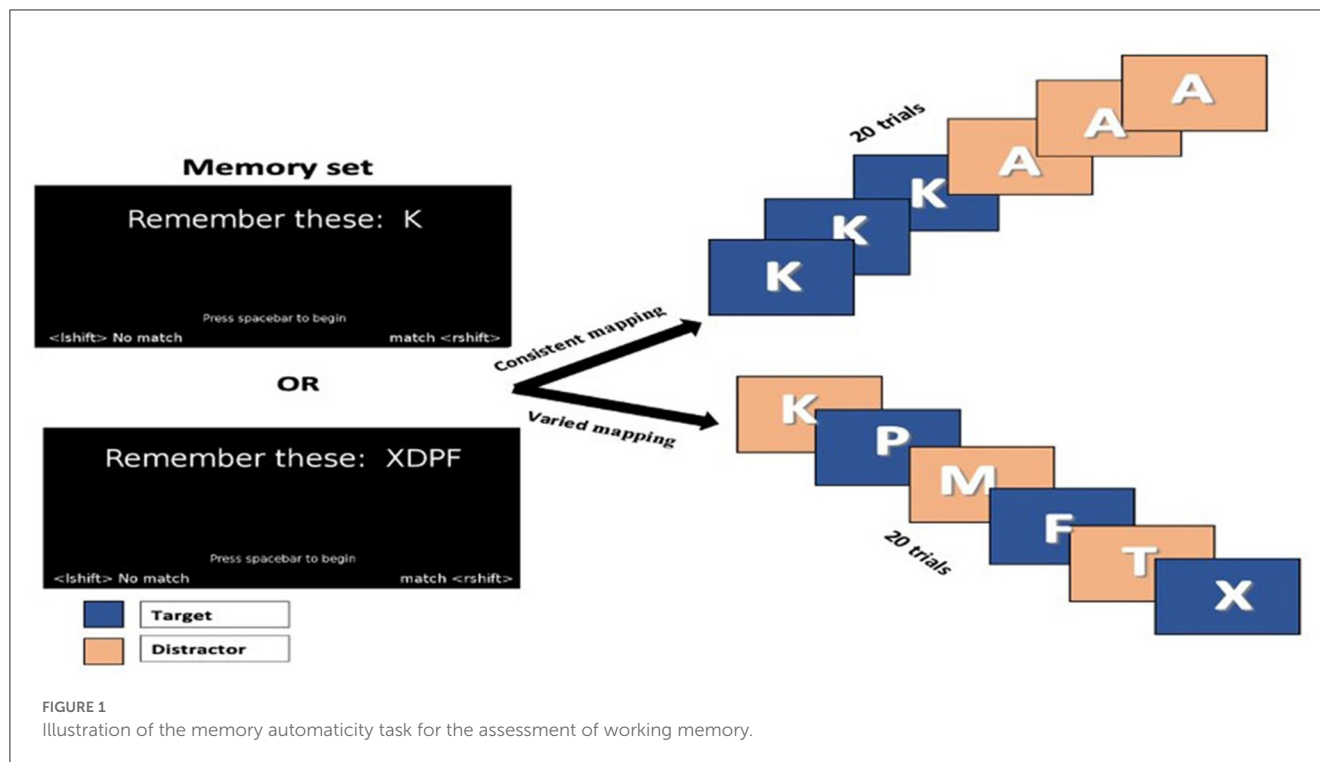
is in a memory set and classifying it accordingly. A memory set is a set of learned alphabets designed to be recognized on a given trial. Letters that match any of the memorized items are called "targets," while letters that do not match any of the memorized items are called "distractors." Response times and accuracy are the dependent metrics. This task has two main components: consistent and varied mapping. Consistent mapping is used when the target and distractor items do not overlap across trials; they are mapped consistently; thus, this task is performed automatically and requires less focus and attention (Schneider and Shiffrin, 1977; Servant et al., 2018; Zhao et al., 2022). Varied mapping is used if the target and distractor items overlap each other. Hence, completing the test requires much more control, focus, and attention than consistent mapping (Schneider and Shiffrin, 1977; Zhao et al., 2022). First, the children were given a memory set of one to four alphabets at two different levels. They were asked to remember one to two alphabets in the first level, while the second level has three to four alphabets. This list of levels came randomly and could be consistent or varied (Figure 1). Once the participants memorized the alphabet in a memory set, they had to press the spacebar to begin; thus, the previous memory set would be deleted, and then, they were shown a series of alphabet inputs. They must decide whether each letter matches one of the alphabets in the memory set previously presented or not. When the letters do not match, they are considered distractors, and the participant responds using the left shift key. Alternatively, consider it a target when it matches and responds using the right shift key.

The Flanker task assesses selective attention control by focusing on a stimulus while simultaneously inhibiting the detection of other stimuli (Servant et al., 2018). This task presented five randomly directed arrows in the screen's center. The participants were asked to determine the direction of the center arrow while ignoring the arrows in the periphery. Both hands' index and middle fingers were placed on the keyboard's right and left shift keys. The children were instructed to respond depending on the direction of the central arrow; if it points left, they should press the left shift key; if it points right, they should press the right shift key as fast as possible. The heads of the arrows surrounding the center arrow would either be in the same or the opposite direction, be absent, or only appear as lines (Figure 2). Before starting the main trials of the task, which had 96 trials, the children were allowed to practice for 10 trials. The overall mean reaction times in milliseconds and the mean accuracy were recorded for analysis. Data from the practice trials were excluded. The participants had approximately 3 min to complete the test. After obtaining all the required data, the children were categorized into the smartphone-addicted and non-addicted groups based on their SAS-SV scores. The scores of cognitive function and physical activity level were collected for further analysis.

Outcome measurements

Smartphone addiction

Smartphone addiction levels were measured using the Arabic version of the Smartphone Addiction Scale-Short Version (SAS-SV) (Kwon et al., 2013a). It is a self-administered scale developed by



Kwon et al. (2013a) and intended to assess smartphone addiction. The SAS-SV had 10 items assessed on a 6-point Likert scale, ranging from “one” for strongly disagree to “six” for strongly agree. The maximum score for the scale is 60, and the minimum score possible is 10 (Kwon et al., 2013a). The SAS-SV addresses five content areas: daily disturbances, tolerance, cyberspace-oriented relationships, overuse, and withdrawal (Haug et al., 2015). The original English scale version had excellent internal consistency, content, and concurrent validity (Kwon et al., 2013b). However, Sfendla et al. (2018) assessed the psychometric properties of the Arabic SAS-SV on the Moroccan sample and found excellent reliability (Sfendla et al., 2018). The Smartphone Addiction Scale-Short Version classified the users as addicts with scores of ≥ 31

for boys and ≥ 33 for girls or non-addicts with scores of < 31 for boys and < 33 for girls. This cutoff point is based on the original article that examined the validity and reliability of the SAS-SV questionnaire (Kwon et al., 2013a).

Cognitive function

The working memory and selective attention domains of cognitive function were assessed using the psychology experiment building language (PEBL) test battery. The PEBL is an open-source software system that is freely available for designing and conducting psychological experiments and is a versatile research tool for studying individual differences in neurocognitive performance

(Piper et al., 2015). It has good reliability and validity (Piper et al., 2015). The battery can be freely downloaded from the website (<http://pebl.sourceforge.net>). However, under the PEBL battery, memory automaticity and Flanker tasks were employed to assess the working memory and selective attention domains, respectively.

Physical activity

The Arabic version of the physical activity questionnaire for older children was used to assess the children's physical activity. The PAQ-C is a self-administered scale designed to assess the children's physical activity in the last 7 days (Kowalski et al., 1997). The original scale has good reliability and validity and was invented to assess physical activity in children aged 8–14 (Benítez-Porres et al., 2016; Gobbi et al., 2016; Wang et al., 2016). In a recent study, the scale was translated into Arabic and proved excellent validity and reliability (Alharbi, 2019). The total number of items in the PAQ-C was nine. Each item on the scale was rated from 1 to 5, and the total score was the average of all the items (Kowalski et al., 1997). The total score ranges from 1 to 5, divided into a low physical activity score of ≤ 2.3 , a moderate physical activity score of 2.4–3.7, and a high physical activity score of ≥ 3.8 (Alharbi, 2019).

Statistics analysis

Data were transferred to a single Excel sheet, and all variables were analyzed using the Statistical Package for the Social Sciences software for Mac (IBM SPSS version: 28.0.1.0, New York, USA). The univariate analysis for the demographic characteristics and outcome measures was done using descriptive statistics. Descriptive statistics were reported as mean \pm standard deviation for quantitative variables. Categorical variables were reported as frequencies and percentages. The normality of the variables' distribution was examined using the Shapiro–Wilk test. A one-way MANOVA was conducted to determine the differences in working memory between the smartphone-addicted and non-addicted groups. To illustrate smartphone addiction's effect on selective attention, the reaction times and accuracy means were compared between the two groups using an independent sample *t*-test. The relationship between smartphone addiction and physical activity was analyzed using the Pearson chi-squared test. The effect size was determined using Cohen's formula, which represents the average effect size as also $d = 0.4$, with 0.2, 0.4, and 0.6 considered small, medium, and large effects, respectively. The interaction effects between physical activity and smartphone addiction on reaction times were analyzed using a 2×3 factorial design. The criterion for statistical significance was set at a *p*-value of ≤ 0.05 .

Results

Based on their smartphone addiction scale-short version scores, the children were categorized into two groups: smartphone-addicted and non-addicted. Moreover, approximately half (49.5%) of the children used their phones for more than 5 h a day, and approximately two-thirds used mobile phones for 2–4 years (66.3%). The mean \pm (SD) of age, height, weight, and body mass index of the included participants was 12.99 ± 0.81 ,

153.86 ± 6.50 , 48.07 ± 7.31 , and 20.22 ± 2.08 , respectively (Table 1).

The difference between the addicted and non-addicted children in response times for both varied, and consistent components was not statistically significant; $F_{(4,191)} = 1.154$, $p = 0.333$; Wilks' $\Lambda = 0.976$; partial $\eta^2 = 0.024$. Furthermore, the difference between the addicted and non-addicted children on accuracy for both varied and consistent components was not statistically significant; $F_{(4,191)} = 0.968$, $p = 0.426$; Wilks' $\Lambda = 0.980$; partial $\eta^2 = 0.020$. The mean response times and accuracy differences between smartphone-addicted and non-addicted children showed that the addicted children had shorter response times and were more accurate than the non-addicted children (Figures 3, 4).

Table 2 shows that the independent sample *t*-test has shown no statistically significant difference in reaction times between smartphone-addicted and non-addicted children ($t = 0.464$, $p = 0.817$). However, the accuracy component showed a statistically significant difference between the groups ($t = 2.617$, $p = 0.005$). The mean accuracy shows that smartphone-addicted children have a higher accuracy rate than non-addicted children. The small effect ($d = 0.066$) was shown between smartphone-addicted and non-addicted children for reaction times, whereas a medium effect ($d = 0.374$) size was shown for accuracy.

Two-way cross-tabulation shows that smartphone-addicted children had lower levels of physical activity. In contrast, non-addicted children had moderate-to-high levels of physical activity. In addition, the Pearson chi-square test showed that this relationship was statistically significant ($X^2 = 84.60$, $p < 0.001$). A large effect size ($\phi = 0.657$) can be observed between addicted and non-addicted children for physical activity levels (Table 3).

Table 4 shows no statistically significant ($p = 0.250$) differences among smartphone-addicted and non-addicted children for low and moderate-to-high physical activity subgroups. Partial eta squared ($\eta^2 = 0.007$) showed very little effect between addicted and non-addicted children for the level of physical activity.

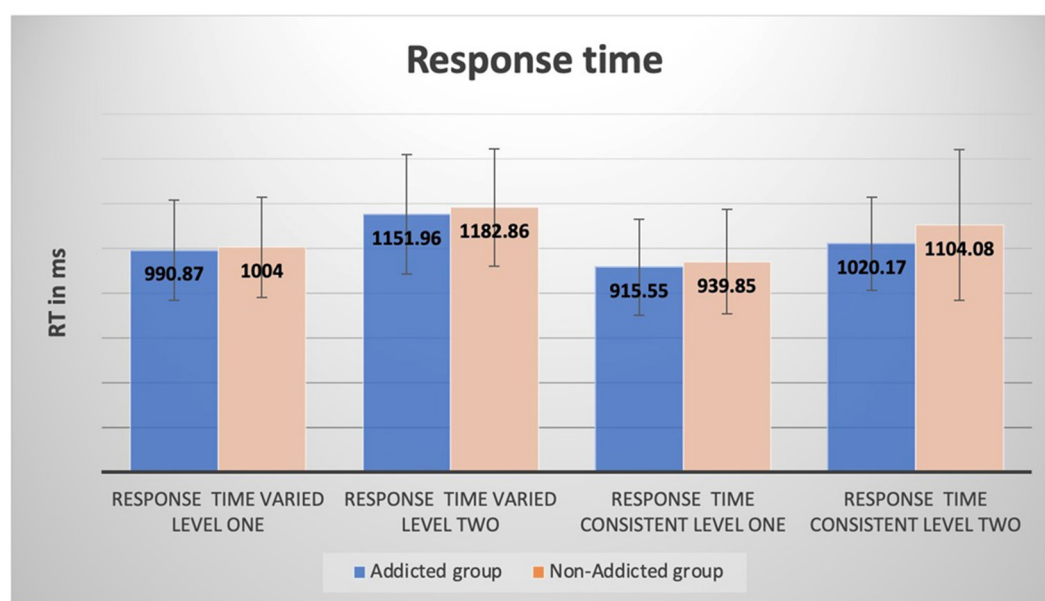
Discussion

The current study aimed to investigate the effects of smartphone addiction on cognitive function and physical activity in middle-school children. According to the present study, there are no significant differences in working memory or reaction times for selective attention tasks between smartphone-addicted and non-addicted children. A significant difference was observed only in the accuracy component of the selective attention task, indicating that the smartphone-addicted children were more accurate than the non-addicted children. Concerning the differences in physical activity between smartphone-addicted and non-addicted children, the present study's results indicate that non-addicted children were significantly more active than smartphone-addicted children. Concerning the interaction effects between smartphone addiction and physical activity, the results have shown no significant interaction effects between physical activity and smartphone addiction on reaction times.

In the present study, mean response time and accuracy values indicated that the smartphone-addicted children performed the working memory task slightly better than the non-addicted children at each level. The smartphone-addicted children had

TABLE 1 Demographic characteristics of total participants and differences between the smartphone-addicted and non-addicted children.

Mean, standard deviation (SD) and frequency distribution of children' characteristics	Addicted (n = 100)	Non-addicted (n = 96)	Total (n = 196)
Mean (SD)			
Age in years	13.11 (0.82)	12.88 (0.78)	12.99 ± 0.81
Height in meters	154.56 (6.40)	153.13 (6.55)	153.86 ± 6.50
Weight in kilograms	48.80 (6.41)	47.31 (8.10)	48.07 ± 7.31
Body mass index kg/(m) ²	20.38 (1.93)	20.05 (2.22)	20.22 ± 2.08
Frequency (Percent)			
Gender			
Male	44 (44 %)	54 (56.3 %)	98 (50 %)
Female	56 (56 %)	42 (43.8 %)	98 (50 %)
Education level			
Middle-school grade 1	29 (29 %)	37 (38.5 %)	66 (33.7 %)
Middle-school grade 2	30 (30 %)	34 (35.4 %)	64 (32.7 %)
Middle-school grade 3	41 (41 %)	25 (26 %)	66 (33.7 %)
Daily smartphone usage time			
<1 h per day	0 (0.0 %)	22 (22.9 %)	22 (11.2 %)
<4 h per day	9 (9 %)	68 (70.8 %)	77 (39.3 %)
More than 5 h per day	91 (91 %)	6 (6.3 %)	97 (49.5 %)
Years of smartphone ownership			
1 year and less	14 (14 %)	28 (29.2 %)	42 (21.4 %)
2–4 years	69 (69 %)	61 (63.5 %)	130 (66.3 %)
More than 5 years	17 (17 %)	7 (7.3 %)	24 (12.2 %)

**FIGURE 3**

Differences between smartphone-addicted and non-addicted children in response time for varied and consistent components at levels 1 and 2.

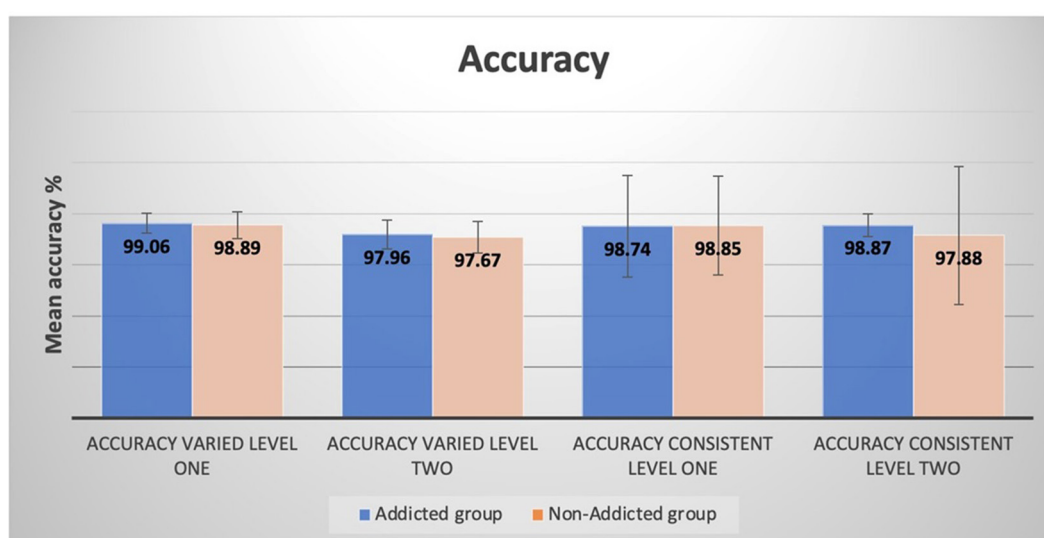


FIGURE 4

Differences in accuracy between smartphone-addicted and non-addicted children for varied and consistent components at levels 1 and 2.

TABLE 2 Reaction times and accuracy differences between smartphone-addicted and non-addicted children.

	Children's groups	Mean	Standard deviation	95% CI		t	p-value	Effect size (d)
				Lower	Upper			
Reaction times (RT)	Addicted	465.73	55.45	-12.138	19.611	0.464	0.817	0.066
	Non-Addicted	461.99	57.23	-12.149	19.622			
Accuracy %	Addicted	91.88	6.72	0.744	5.300	2.617	0.005*	0.374
	Non-Addicted	88.86	9.29	0.727	5.316			

*Significant at 0.05 level.

TABLE 3 Relationship between smartphone addiction and physical activity.

		Physical activity levels (number)			Pearson chi-square (χ^2)	p-value	Effect size (phi)
		Low	Moderate	High			
Children's groups	Addicted (n = 100)	61	39	0	84.60	<0.001*	0.657
	Non-addicted (n = 96)	10	38	48			

*Significant at 0.05 level.

TABLE 4 Interaction effects between physical activity and smartphone addiction on reaction times.

Children's groups	Physical activity levels	Mean	SD	95% CI		F	p-value	Partial eta squared
				Lower	Upper			
Addicted	Low	457.41	55.025	443.211	471.607	1.330	0.250	0.007
	Moderate	478.74	54.281	460.988	496.501			
Non-addicted	Low	469.23	52.791	434.158	504.292			
	Moderate	463.96	51.576	445.973	481.951			
	High	458.93	63.001	442.923	474.934			

shorter mean response times and were more accurate than the non-addicted children for varied and consistent mapping components. These findings suggest that smartphone-addicted children might remember the selected target faster and more accurately than non-addicted children might, which contradicts the current study's hypothesis. Most of the children in this study had been repetitively using their smartphones for more than 5 h per day for 2–4 years. Therefore, considering that smartphone overuse could enhance the user's sensory-motor coordination, decrease their response time, and increase their accuracy (Grewal and Sahni, 2019; Jordan and Dhamala, 2022). Moreover, the current study's working memory assessment depends on a computer-based task. As a result, smartphone-addicted children could complete tasks better and more efficiently than non-addicted children as they are more familiar with using such devices than non-addicted children.

Furthermore, working memory performance may improve with practice because of the brain's plasticity (Jak, 2012; Choudhury and McKinney, 2013). Imren and Tekman found that media multitasking improves working memory but inhibits the ability to sustain attention. They hypothesized that these results might have occurred because multitasking requires working memory practice, and media multitasking involves switching between devices or their functions (Imren and Tekman, 2019). Therefore, working memory performance can increase with practice, improving cognitive function (Jak, 2012; Choudhury and McKinney, 2013; Loh and Kanai, 2016). In addition, Tanaka et al. (2013) indicated that smartphone addicts had greater gray matter volume in the posterior parietal cortex, which was associated with better visual working memory performance (Tanaka et al., 2013). However, statistically, there are no significant differences in working memory between smartphone-addicted and non-addicted children. The lack of statistically significant differences in the memory (accuracy) task may be attributed to the limited differences between the addicted and non-addicted children with regard to cognitive functions, making it difficult to draw statistically significant differences. Studies have demonstrated that childhood and adolescence are characterized by the continuous development and maturation of various prefrontal cortex-mediated behaviors, including planning, attentional control, working memory, inhibitory control, and decision-making (Hooper et al., 2004; Conklin et al., 2007; Luciana et al., 2009).

The attention domain of cognitive function assessed by the Flanker task is based on reaction times in milliseconds and accuracy. Regarding reaction times, the current study showed no statistically significant difference between smartphone-addicted and non-addicted children. In a recent neurophysiological study, researchers aimed to determine whether excessive smartphone use is accompanied by measurable neural, cognitive, and behavioral changes. They conducted a longitudinal experiment to identify smartphone use's effects on the participants' cognitive functions and to observe the differences between heavy smartphone users and non-users. They found that heavy smartphone users were experiencing hyperactivity and increased impulsivity. Moreover, heavy smartphone users had reduced early transcranial magnetic stimulation-evoked potentials induced by transcranial magnetic stimulation on the right side of the prefrontal cortex compared to non-smartphone users, which were associated with self-reported inattention problems. However, the researchers did not observe significant differences between the groups' memory domains

(Hadar et al., 2017). Consistent with the study mentioned above, the current study found no significant differences in the memory domain of cognitive function between smartphone-addicted and non-addicted children. However, regarding the attention function, the current study's findings contradict the previous study's results. The current study's results showed no statistically significant difference between smartphone-addicted and non-addicted children in the reaction time of the attention domain. In contrast, the prior study found that heavy smartphone use was significantly associated with inattention problems. The differences in results could be attributed to the methodological differences in how the studies were conducted.

The study mentioned above used the Conners Adult ADHD Rating Scales (CAARS) questionnaire to assess inattention, whereas the present study used a computer-based test. Paper-based questionnaire assessments are different from computer-based tests. In paper-based tests, all the questions are in front of the participant at once, allowing them to move between questions as they wish, which may increase the chance of bias and error. In computer-based tests, by contrast, questions are presented one after the other with limited time to complete the task; therefore, participants have no opportunity to return to previously posed questions, which may help provide more accurate results of the attention function. However, we currently lack evidence to support this intuitive interpretation, so we cannot completely exclude it.

The above-described study's sample included only adults, whereas the current study's participants were children. The developmental stage of childhood is characterized by ongoing neurological growth, which distinguishes children from adults (Larsen and Luna, 2018). There is substantial evidence to indicate that children influence attentional performance. For instance, the capacity to sustain attention, inhibit inappropriate responses, and shift attentional focus improves throughout childhood (Halperin et al., 1991; Greenberg and Waldman, 1993). Therefore, it is difficult to definitively judge smartphone addiction's effect on children's attention functions. However, the difference in the effects of smartphone addiction on attention function between adults and children indicates the possibility of adverse long-term effects. These results sparked further curiosity of the current study's team to move research forward, conduct a longitudinal study, and include a wide range of age groups to uncover more results.

The current study's findings have shown no statistically significant difference in reaction times between smartphone-addicted and non-addicted children. However, smartphone-addicted children had a significantly higher accuracy rate than non-addicted children in the attention task. One possible explanation for the smartphone-addicted children's high accuracy rate could be the experience and skills acquired by these children from using smartphones. Smartphone-addicted children have been using the smartphone, repetitively, for an extended period, which could have enhanced their neuronal circuits, thus increasing their ability to filter irrelevant information. In a series of studies by Dye et al. (2009), and Bavelier et al. (2012) increased media multitasking was associated with better attention control; they found that smartphone-addicted participants were better at inhibiting irrelevant information than other groups (Dye et al., 2009; Bavelier et al., 2012). In addition, a recent study found that smartphone-addicted participants were more attentive than their counterparts (Alsaad et al., 2022).

Regarding smartphone addiction's effect on physical activity, the current study confirmed the link between smartphone addiction and low physical activity. The findings showed that smartphone-addicted children were less physically active. In contrast, non-addicted children are likelier to have moderate-to-high physical activity levels. Furthermore, this association was statistically significant. In agreement with the present study's results, Azam et al. (2020) conducted a systematic review to emphasize the links between smartphone addiction, sports participation, and physical activity. Their review included eight global studies, all of which had been conducted on children and adolescents. All the studies included in their review showed similar results, demonstrating that an increase in smartphone use leads to decreases in physical activity and sports performance among children and adolescents (Azam et al., 2020). Similarly, Wang et al. (2016) revealed that smartphone addiction decreases physical fitness among university students (Li et al., 2022).

The present study's secondary objective was to identify the interaction effects between physical activity and smartphone addiction on reaction times. It could be considered that the effects of physical activity on reaction times depend on the levels of smartphone addiction. Therefore, smartphone-addicted and non-addicted children were divided into low and moderate-to-high physical activity subgroups based on the physical activity questionnaire. However, there were no significant interaction effects between physical activity and smartphone addiction on reaction times. These findings indicate that the effect of physical activity on reaction times did not depend on whether the children were addicted or non-addicted to smartphones. These results could be attributed to the fact that reaction times depend on many other factors, including gender (Naglieri and Rojahn, 2001), sleep quality (Paavonen et al., 2010), children's birth order, residence, breakfast intake, and the mother's smoking history (Almomani et al., 2014). However, the current study did not investigate such factors' effects on reaction times. Notably, studies have yet to examine the interaction effects between physical activity and smartphone addiction on reaction times.

This study also has several limitations, which indicate possibilities for further investigation. First, the cross-sectional study design prevents any cause-effect relationship. Further longitudinal investigation is required to determine the directionality of the investigated correlations. Second, the sample was a specific age group, and all participants were recruited only from schools in the eastern region, which may affect the likelihood of generalizability. Third, there was no intervention used to determine the cause-and-effect assumptions. Fourth, self-reported questionnaires were used to determine the level of physical activity and smartphone addiction behavior that may lead to biases. Fifth, the study investigated smartphone addiction in only two cognitive domains: working memory and selective attention. Future researchers can investigate the impact of smartphone addiction on other neurocognitive domains, such as problem-solving and planning, helping to highlight the other cognitive domains that could be affected by smartphone addiction. Finally, smartphone addiction is complicated and multidimensional. Thus, examining the varied activities, contents, and patterns of smartphone use in future research would be beneficial.

Conclusion

The present study demonstrated that smartphone-addicted children were significantly more accurate than non-addicted children. Non-addicted children had significantly higher physical activity levels than addicted children. Smartphone-addicted children have shorter response times and are more accurate than non-addicted children in working memory tasks for varied and consistent mapping. In addition, the current study showed no significant interaction effects between physical activity and smartphone addiction on reaction times, indicating that the effect of physical activity on reaction times did not depend on smartphone addiction levels. Further studies are required to corroborate findings and aid in developing preventative and intervention measures.

Data availability statement

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

Ethics statement

The studies involving human participants were reviewed and approved by the Imam Abdulrahman Bin Faisal University, Dammam. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

AA-A, SA, and TA: conceptualization. AA-A: data curation, investigation, and writing—original draft. SB: formal analysis and software. AA-A and TA: methodology. SB and MA: resources and writing—reviewing and editing. SA, MA, and TA: supervision. SA and TA: validation. SA and MA: visualization. All authors contributed to the article and approved the submitted version.

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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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Predictors for runaway behavior in adolescents in South Korea: national data from a comprehensive survey of adolescents

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Background: Runaway behavior is reported to impede the growth, mental health development, and social adjustment of adolescents. Exposure to harmful media causes problematic behaviors in adolescents, sometimes inducing them to run away from home.

Methods: This study examined the factors influencing adolescents' runaway behavior. Utilizing the data of 11,354 adolescents from the Survey of Media Usage and Harmful Environment among Adolescents, a hierarchical logistic regression analysis was conducted using the SPSS 24.0 program.

Results: The significant predictors of runaway behavior were the grade of the adolescent, deviant behaviors (drinking, smoking), autonomous control ability, relationship with family, and harmful media ($p < 0.001$). This regression model explained 13.1% of the variance in runaway behavior. A significant outcome of this study is that harmful media was identified as one of the factors affecting adolescents' runaway behavior. Adjusted OR and 95% CI of harmful media was 1.23 (1.10–1.38).

Conclusion: This study showed that individual, family, social factors, and harmful media influence adolescents' runaway behavior. The results emphasize the importance of health teachers and the need for early intervention programs, for the identification and prevention of risk factors for adolescents' runaway behavior.

KEYWORDS

adolescent, runaway behavior, media, family relations, ecological

1. Introduction

1.1. Tendencies and characteristics of south Korean adolescent runaways

In 2021, 3.2% of adolescents said they had run away from home in the past year, an increase of 0.3% compared to the previous year. The percentages of adolescents who had run away from home in the previous year were 2.7% of middle school students, 2.6% of high school students, and 2.1% of elementary school students in South Korea (1).

By age, 55.5% of adolescents run away from home between the ages of 13 and 15 (1), and the number of runaways among elementary school students is increasing. This reflects that runaway behavior is occurring at a younger age (1–4).

Adolescence is a critical transitional period where one establishes their ego-identity and undergoes rapid changes in one's body, cognition, emotion, morality, and social identity (5, 6). Overall, individuals tend to engage in more risky behaviors in adolescence than in any other developmental stage (7). Runaway adolescents are exposed to alcohol and drugs (8–10) and exhibit psychological problems such as depression (11), self-injurious behavior (12), and suicidal tendencies (8, 10, 13). They are also introduced to many developing antisocial and delinquent behavior such as dropping out of school, theft for a living, rape, prostitution (6, 13, 14), and physical violence (15, 16). Runaway behavior serves as a major variable that interferes with growth, development of mental health, and social adaptation in adolescents (5, 13). As runaway behavior is emerging as a serious social problem that adversely affects adolescents and the community, active intervention is needed (4). A harmful environment disrupts the mature and healthy development of adolescents (6), influencing their delinquent behavior (4, 17). Recently, the types of harmful environments have diversified and become highly accessible (6), which has led to adolescents being increasingly exposed to them while they spend time with their peers (18, 19). Exposure to a harmful environment may serve as a mediator of adolescents' delinquency behavior (18), and the experience of adolescents' visits to harmful facilities such as karaoke bars, pubs, nightclubs, and video rooms, is emerging as a social problem encouraging them to run away from home (17, 20). Harmful media for juveniles are media such as movies, videos, adult gaming, music, performances, the internet, publications, and advertisements that contain sexually suggestive and violent content harmful to young people and are therefore inappropriate for distribution to young people (21).

In 2021, 4 out of 10 teenagers (37.0%) were at risk of over-dependence on smartphones, and the risk group for over-dependence on smartphones increased by 1.2% points year-on-year (1).

The increase in smartphone usage is drawing serious attention as a factor contributing to increased exposure to harmful media (2) as 76.1% of adolescents were using the internet and mobile messenger apps almost daily, and 95% were using smartphones for exposure to media such as adult videos or magazines, and adult online games (22). These results indicate an increasing risk of adolescents' exposure to harmful internet content through excessive use of smartphones (1, 22).

The technology-driven social structure also provided new models and opportunities for teenagers to form "runaway fams." They live in groups and call themselves a "runaway fam." These "runaway fams" are associated with group crimes committed by organized, intelligent, and cruel adolescents in South Korea (23), causing complicated social problems.

1.2. Predictors of runaway behavior among youth

The factors influencing adolescents' runaway behavior are discussed from an individual, family, and social environmental perspective: individual factors, such as being female (22, 24, 25),

gender (26, 27), being 15 years of age or older (28), types and grade levels in school (29), and ego identity (5); family factors such as single-parent family (3, 30), conflict with parents (11, 31), parental attachment (14), and physical abuse (25, 26); and environmental factors such as academic performance at school (4, 25, 31), being a victim of violence at school (24, 26, 30), and the local community one resides in Moon, Cauffman et al., and Heerde et al. (3, 20, 31). These problems are influenced not by a single factor such as school, family, or individual but by a combination of these within the environment (13). To understand this, an approach with an ecological system perspective that focuses on explaining the process of individuals maintaining dynamic balance or undergoing changes, while influencing one another through ongoing social interaction (14, 25), is required.

A considerable amount of research on adolescents has integrated a risk factor approach to Bronfenbrenner's ecological systems framework (32, 33) to identify multiple risk factors that increase youths' vulnerability and susceptibility to negative developmental outcomes.

The ecological perspective focuses on explaining the process of maintaining or changing the dynamic equilibrium, influencing individuals through interactions with each other while living in a particular environment (14, 34). According to the ecological approach, adolescents grow and develop within diverse and complicated socio-environmental systems, emphasizing the importance of the environment as a part of this system for youth (26). An integrated ecological framework of risk factors for runaway behavior would suggest that multiple risk factors are related to runaway behavior and that these factors are "nested" and operate at multiple levels, including the individual (e.g., sociodemographic factors, child abuse, substance abuse), familial (e.g., family instability), and extra-familial levels (e.g., school factors, peer networks) (35–39).

Gottfredson and Hirschi's theory of low self-control has generated a considerable amount of research and the results of these studies have shown that low levels of self-control are consistently associated with involvement in antisocial outcomes (40). The current study examines the efficacy of low self-control in predicting the involvement of South Korean adolescents in typical delinquency, drinking, smoking, Internet addiction, and smartphone addiction (41). Autonomy is regarded as one of the basic psychological needs that contribute to adaptive psychosocial functions. Such a psychological need is particularly highlighted in adolescence due to the increased demand for autonomy-seeking during this period (42).

According to Gottfredson and Hirschi's Generality Hypothesis, people who lack self-control are risk taking and they are also more likely to experience problems in social relationships, such as drug and alcohol abuse. They also argue that the cause of low self-control lies with parents and that parents should be able to monitor their children, recognize bad behaviors, and correct these bad behaviors. Based on this, it is necessary to comprehensively examine the self-control ability and the relationship with parents as influencing factors for adolescents running away from home. Previous studies analyzing the correlation between adolescents' runaway behavior and individual (self-esteem), family (conflicts or support), and school factors (teacher support) (3), as well as other influencing factors, have limitations in only elucidating unilinear relationships among the variables.

Studies investigating influencing factors for runaway behavior (25, 26) only examined the current status of runaways. Only a few studies

have comprehensively investigated the cause of adolescents' runaway behavior by studying environmental factors such as harmful media that can affect adolescents, in addition to individual factors based on the current status of runaways.

To understand adolescents' runaway behavior, it is important to understand its risk factors early and to proactively intervene and prevent them rather than prepare countermeasures. Therefore, in this study, a multi-level analysis was done of the relationships between runaway experience and individual, family, and social factors; harmful media; and other influencing factors. The analysis is based on the raw statistics data from the "Comprehensive Survey of Adolescents' Contact with Media Usage and Harmful Environment" to provide basic data for preparing coping measures and programs that can reduce runaway behavior in adolescents.

1.3. The purpose of the study

This study aims to understand the factors influencing the runaway experience in Korean adolescents.

First, it examines the differences in general characteristics of adolescents according to the presence of runaway experience. Second, it examines the differences in runaway frequency according to general characteristics of adolescents and differences in related variables according to the presence of runaway experience. Third, the factors associated with adolescents' runaway experience are determined.

2. Materials and methods

2.1. Data collection

This study is a secondary data analysis of the 2016 Comprehensive Survey of Adolescents' Contact with Media Usage and Harmful Environment (2). The survey was conducted by the Ministry of Gender Equality and Family and the National Youth Policy Institute to secure basic data for establishing youth protection policies by understanding the current status of adolescents' exposure to harmful environments in Korea. In basic research, the basic framework for the nature and content organization of integrated investigations was established. In order to faithfully achieve the purpose of the survey, which is to be used as basic data for policy responses related to youth protection, the overall content of the raw data was organized in a way that increased the degree of policy adherence compared to the previous survey (2).

Applying probability sampling, the participants were extracted using multistage cluster sampling. Poststratification weights were calculated by considering the size of the population by gender according to 17 cities/provinces and types of schools. The participants were 11,354 middle and high school students. The statistical data were granted confidentiality according to the Statistics Act No. 33.

2.2. Measurements

In this study, the following variables were used among the questionnaire items surveyed among adolescents by the Ministry of Gender Equality and Family (2).

2.2.1. General characteristics

Gender was determined by a choice of "1: male, 2: female." The categories of "drinking experience," "smoking experience," and "e-cigarette smoking experience" were determined by a choice of "1: yes, 2: no."

2.2.2. Autonomous control ability

Autonomous control ability was assessed by six items: "I am controlled by other people," "I have few opportunities to decide things on my own," "I often have to do what other people tell me to do in everyday life," "I can freely express my thoughts and opinions in general," "I can decide how to live my life on my own," and "when I do something, I often follow other people's way of thinking and acting rather than following my own." Scores were calculated according to the scale of "1: strongly disagree, 2: disagree, 3: agree, 4: strongly agree." In this study, Cronbach's alpha was 0.76.

2.2.3. Relationships with family, friends, and school teachers

Relationships with family, friends, and school teachers were assessed by five items. The subjects answered a total of 15 questions, each with 5 questions in relation to family, friends, and school teachers. "They (ex, family, friends, or school teachers) make me feel I'm loved and being taken care of," "They are willing to listen to my worries and concerns," "I can completely rely on them," "They always pay attention to me and worry about me," and "When I'm reluctant to make a decision, they would encourage me and reassure me." Scores were calculated on a scale of 1: strongly disagree, 2: disagree, 3: agree, 4: strongly agree. In this study, Cronbach's alpha was 0.95 for family relationships, 0.95 for friend relationships, and 0.96 for school teacher relationships.

2.2.4. Experience of violence

Experience of violence was assessed by the following items: "I constantly hear curses or demeaning words targeted at me," "I have been injured by hitting and kicking or by use of an object," "Money or my other possessions have been taken from me," "I have been bullied," "I have been forced to do other's chores," and "I have been a victim of cyber bullying." Each item was answered either "1: yes, 2: no." Scores were calculated according to "1: yes, 0: no."

2.2.5. Experience of exposure to harmful media

Experience of exposure to harmful media was measured by a total of five questions; two asked whether the participants had watched R-rated adult videos or magazines in the past year, and three asked whether the participants had used new or variations of harmful media such as adult online games, gambling games involving betting money or cyber money, and messengers or chat apps for conditional dating in the past year. Each question was answered either "1: yes, 2: no." Scores were calculated according to "1: yes, 0: no."

2.2.6. Runaway experience

Runaway experience was measured by responding "1: yes, 2: no" to "presence of runaway experience in the past year." Runaway is defined as when a youth leaves home without the consent of a parent or guardian and does not return home for more than 24h during the past year. The frequency of runaway experience was measured according to "1: none, 2: once, 3: twice or more."

2.3. Data analysis

As the survey statistics data were collected by complex sampling design, complex sampling analysis was used to obtain the results. For the number of samples for each variable by item, the actual sample numbers from the raw data used in this study's statistical analysis were used. Data were analyzed using the Statistical Package for Social Sciences IBM (SPSS-IBM), version 24 (SPSS, Inc., Chicago, Illinois, United States). The general characteristics of the variables were analyzed using descriptive statistics (frequency, percentage, mean, standard deviation). Differences in runaway experience according to general characteristics and related variables were analyzed by the χ^2 test and Fisher's exact test for the categorical variables and a t-test for the continuous variables. Hierarchical logistic regression was used to determine the factors associated with the runaway experience of adolescents. The maximum value of variance inflation factor (VIF) between independent variables was 1.61, which was far below 10, and the minimum value of tolerance was 0.62, far above 0.20. Hence, there was no issue with multicollinearity. Obtaining informed consent was exempted by the Institutional Review Board (IRB) of Chosun University (IRB no. 2-1041055-AB-N-01-2019-34) because data were from the Comprehensive Survey of Adolescents' Contact with Media Usage and Harmful Environment.

3. Results

3.1. General characteristics according to runaway experience

Analysis of differences in general characteristics according to runaway experiences revealed statistically significant differences in gender ($\chi^2 = 11.09$, $p < 0.001$), age ($\chi^2 = 7.62$, $p = 0.006$), drinking ($\chi^2 = 66.03$, $p < 0.001$), smoking ($\chi^2 = 86.19$, $p < 0.001$), and e-cigarette

smoking ($\chi^2 = 72.73$, $p < 0.001$) according to runaway experience (Table 1).

3.2. Frequency of runaway experience according to general characteristics

Analysis of differences in the frequency of runaway experience according to general characteristics revealed statistically significant differences in gender ($\chi^2 = 11.00$, $p = 0.004$), age ($\chi^2 = 6.00$, $p = 0.049$), drinking ($\chi^2 = 94.89$, $p < 0.001$), smoking ($\chi^2 = 138.58$, $p < 0.001$), and e-cigarette smoking ($\chi^2 = 111.69$, $p < 0.001$).

The runaway experience was higher in males with 2.1% "once" and 1.6% "twice or more" than in females with 1.5% "once" and 1.1% "twice or more." It was significantly higher in those aged 13–16 years with 1.9% "once" and 1.7% "twice or more" than for those aged 17–20 with 1.7% "once" and 1.1% "twice or more." The frequency of runaway experience was significantly higher in those who drank alcohol with 3.2% "once" and 2.4% "twice or more" than in non-drinkers with 1.1% "once" and 0.8% "twice or more"; in smokers with 4.0% "once" and 5.2% "twice or more" than in non-smokers with 1.5% "once" and 0.9% "twice or more"; and in e-cigarette smokers with 3.8% "once" and 6.0% "twice or more" than those in e-cigarette non-smokers with 1.6% "once" and 1.0% "twice or more" (Table 2).

3.3. Differences in related variables according to runaway experience

Among the participants, 338 had runaway experiences. The mean value of their autonomous control ability was 2.99 ± 0.01 , relationship with friends was 3.21 ± 0.01 , relationship with family was 3.33 ± 0.01 , and relationship with teachers was 2.99 ± 0.02 . Experience of violence was 0.14 ± 0.01 , and the experience of exposure to harmful media was

TABLE 1 General characteristics according to runaway experience ($N = 11,354$).

Variables	Categories	Total	Runaway experience		χ^2 *(p)
			Yes	No	
		n (%*)	n (%*)	n (%*)	
Gender†	Male	5,583 (52.3)	207 (3.7)	5,376 (96.3)	11.09 (<0.001)
	Female	5,087 (47.7)	133 (2.6)	4,954 (97.4)	
Age (year)‡	13–16	5,117(48.0)	184(3.6)	4,933(96.4)	7.62 (0.006)
	17–20	5,544(52.0)	154(2.8)	5,390(97.2)	
Drinking§	Yes	3,739(35.1)	211 (5.6)	3,528 (94.4)	66.03 (<0.001)
	No	6,918 (64.9)	129 (1.9)	6,789 (98.1)	
Smoking¶	Yes	1,224 (11.5)	112 (9.1)	1,112 (90.9)	86.19 (<0.001)
	No	9,444 (88.5)	228 (2.4)	9,216 (97.6)	
Electronic cigarette¶	Yes	848 (8.0)	83 (9.8)	765 (90.2)	72.73 (<0.001)
	No	9,818 (92.0)	257 (2.6)	9,561 (97.4)	

*Calculated by complex sample analysis.

†Skipped responses were excluded ($n = 10,869$).

‡Skipped responses were excluded ($n = 10,861$).

§Skipped responses were excluded ($n = 10,857$).

¶Skipped responses were excluded ($n = 10,865$).

¶Skipped responses were excluded ($n = 10,864$).

TABLE 2 Frequency of runaway experience according to general characteristics ($N = 11,354$).

Variables	Categories	Total	Runaway frequency			χ^2 (p)
			Never	Once	Twice or more	
		n (%)	n (%)	n (%)	n (%)	
Gender	Male	5,583 (52.3)	5,376 (96.3)	118 (2.1)	89 (1.6)	11.00 (0.004)
	Female	5,087 (47.7)	4,954 (97.4)	76 (1.5)	57 (1.1)	
Age (year)	13–16	5,117 (48.0)	4,933 (96.4)	98 (1.9)	86 (1.7)	6.00 (0.049)
	17–20	5,544 (52.0)	5,390 (97.2)	94 (1.7)	60 (1.1)	
Drinking	Yes	3,739 (35.1)	3,528 (94.4)	120 (3.2)	90 (2.4)	94.89 (<0.001)
	No	6,918 (64.9)	6,789 (98.1)	73 (1.1)	56 (0.8)	
Smoking	yes	1,224 (11.5)	1,112 (90.9)	49 (4.0)	63 (5.2)	138.58 (<0.001)
	no	9,444 (88.5)	9,216 (97.6)	145 (1.5)	83 (0.9)	
Electronic cigarette	Yes	848 (8.0)	765 (90.2)	32 (3.8)	51 (6.0)	111.69 (<0.001)
	No	9,818 (92.0)	9,561 (97.4)	161 (1.6)	95 (1.0)	

*Calculated by complex sample analysis.

TABLE 3 Research variables according to adolescents' runaway experiences ($N = 11,354$).

Variables	Total sample ($n = 11,354$)	Runaway*		t	p
		Yes ($n = 338$)	No ($n = 10,531$)		
	$M \pm SD$	$M \pm SD$	$M \pm SD$		
Autonomous control ability	2.99 ± 0.01	2.81 ± 0.03	2.99 ± 0.01	-7.35	<0.001
Relationship with friends	3.21 ± 0.01	3.08 ± 0.05	3.21 ± 0.01	-2.35	0.023
Relationship with family	3.33 ± 0.01	2.94 ± 0.04	3.34 ± 0.02	-10.38	<0.001
Relationship with teacher	2.99 ± 0.02	2.85 ± 0.06	2.99 ± 0.02	-2.53	0.015
Experience of violence victimization	0.14 ± 0.01	0.46 ± 0.05	0.13 ± 0.01	6.09	<0.001
Harmful media	0.99 ± 0.02	1.53 ± 0.08	0.98 ± 0.02	7.32	<0.001

*Skipped responses were excluded ($n = 10,869$).

0.99 ± 0.02 . Analysis of differences in related variables according to runaway experience indicated that autonomous control ability was significantly higher in the non-runaway group (2.99 ± 0.01) than in the runaway group (2.81 ± 0.03 ; $t = -7.35$, $p < 0.001$).

Relationships with friends ($t = -2.35$, $p = 0.023$), relationships with family ($t = -10.38$, $p < 0.001$), and relationships with teachers ($t = -2.53$, $p = 0.015$) were significantly lower in the runaway group than in the non-runaway group. Experience of violence ($t = 6.09$, $p < 0.001$) and exposure to harmful media ($t = 7.32$, $p < 0.001$) were significantly higher in the runaway group than in the non-runaway group (Table 3).

3.4. Factors influencing adolescents' runaway experience

For Model 1, hierarchical logistic regression was performed by introducing demographic characteristics that displayed significant differences in univariate analysis to determine the factors associated with adolescents' runaway experiences.

Model 1 indicated that age, drinking, and smoking are predictors influencing runaway experience and the regression model was

significant (Wald $\chi^2 = 306.82$, $p < 0.001$). The Cox and Snell R^2 value was 0.019 and the Nagelkerke R^2 value was 0.078. For Model 2, autonomous control ability, relationship with friends, relationship with family, relationship with teachers, the experience of violence, and experience of exposure to harmful media were added. Model 2 revealed that the independent variables that were associated in Model 1 were significant. They were also predicted by an autonomous control ability, relationship with family, the experience of violence, and experience of exposure to harmful contents, and the regression model was significant (Wald $\chi^2 = 766.44$, $p < 0.001$). The Cox and Snell R^2 value was 0.032, and the Nagelkerke R^2 value was 0.131 (Table 4). Those aged 13–16 years had increased runaway experience compared to those aged 17–20 years by 2.20 (95% CI 1.75–2.77). Drinking showed increased runaway experience compared to non-drinking by 2.19 (95% CI 1.73–2.78), and smoking showed increased runaway experience compared to non-smoking by 2.00 (95% CI 1.38–2.89).

Higher autonomous control ability showed decreased runaway experience by 0.76 (95% CI 0.62–0.94), while a higher level of positive perception toward family relationships showed decreased runaway experience by 0.48 (95% CI 0.41–0.57). Increasing experience of violence showed an increase in runaway experience by 1.29 (95% CI

TABLE 4 Factors influencing adolescents' runaway experience ($N = 11,354$).

Categories (reference)		Model 1 [†]						Model 2 [‡]					
		B	S.E	OR	95%CI		<i>p</i>	B	S.E	OR	95% CI		<i>p</i>
					Low	High					Low	High	
Constant		−4.507	0.157	-	-	-	<0.001	−2.426	0.396				<0.001
Gender	Female	Reference											
	Male	−0.054	0.120	0.95	0.75	1.20	0.654	−0.018	0.157	0.98	0.72	1.34	0.908
Age (year)	17–20	Reference											
	13–16	0.783	0.129	2.19	1.70	2.82	<0.001	0.789	0.117	2.20	1.75	2.77	<0.001
Drinking	No	Reference											
	Yes	1.006	0.122	2.74	2.15	3.47	<0.001	0.785	0.122	2.19	1.73	2.78	<0.001
Smoking	No	Reference											
	Yes	0.809	0.184	2.25	1.57	3.23	<0.001	0.691	0.189	2.00	1.38	2.89	<0.001
Electronic cigarette	No	Reference											
	Yes	0.468	0.248	1.60	0.98	2.60	0.06	0.416	0.241	1.52	0.95	2.43	0.085
Autonomous control ability								−0.276	0.107	0.76	0.62	0.94	0.010
Relationship with friends								0.221	0.195	1.25	0.85	1.83	0.258
Relationship with family								−0.730	0.086	0.48	0.41	0.57	<0.001
Relationship with teacher								0.044	0.163	1.04	0.76	1.44	0.790
Experience of violence victimization								0.256	0.052	1.29	1.17	1.43	<0.001
Experience of harmful media								0.209	0.057	1.23	1.10	1.38	<0.001
Wald χ^2 (<i>p</i>)		306.82 (<0.001)						766.44(<0.001)					
Cox and Snell R^2		0.019						0.032					
Nagelkerke R^2		0.078						0.131					
C		0.704						0.774					

[†]Skipped responses were excluded ($n = 10,789$).[‡]Skipped responses were excluded ($n = 10,783$).

*OR, Odds ratio; CI, Confidence interval; C, concordance index.

1.17–1.43) and increasing experience of exposure to harmful media showed an increase in runaway experience by 1.23 (95% CI 1.10–1.38; Table 4).

4. Discussion

4.1. Characteristics of adolescents according to runaway experience

First, among the general characteristics, adolescents' runaway experiences according to individual factors showed differences in gender and age. Studies (3, 25, 26, 43) have reported more runaway experiences in female adolescents.

However, there was a difference in our results as male adolescents ran away from home more than female. The results of this study agree that gender is a significant variable, but which gender is higher in runaways and frequency differs from previous studies. Whether other characteristics affect the result in association with gender difference needs to be further examined through objective and comprehensive replication studies. Furthermore, differential strategies according to gender characteristics should be established. Lee (29) and Oh (26) determined age to be an influencing factor of runaway experience,

showing results similar to this study. However, Kim (27) showed no difference in runaway experience between middle school and high school students, which is in contrast to this study's results. However, a decrease in starting age for adolescents' runaway behavior (1) as well as an increase in runaway frequency was verified in this study. As a runaway experience at a younger age can increase the number of runaway experiences, proper and early intervention is required.

Next, this study's results indicated that drinking, smoking, and e-cigarette smoking were linked to differences in runaway experiences. This is in line with Seng (44), who reported that runaway adolescents indulge in drinking and smoking the most.

Analyzing differences in the degrees of related variables according to runaway experience showed differences according to autonomous control ability, relationship with friends, relationship with family, relationship with teachers, the experience of violence, and the experience of exposure to harmful media.

4.2. The complex predictors in runaway behavior among youth

To determine the variables that predict runaway experience among those that exhibited differences in the univariate analysis,

hierarchical logistic regression was performed by introducing individual characteristics, autonomous control ability, the experience of violence, and experience of exposure to harmful media through two stages.

The level of influence by outcome variables could be compared according to the stage. In the first stage, age, drinking, and smoking, which are individual characteristics, were determined as variables affecting the runaway experience. In the second stage, age, drinking, smoking, autonomous control ability, relationship with family, the experience of violence, and the experience of exposure to harmful media were determined as significant variables affecting runaway experience. The explanatory power was 7.8% when only individual characteristics were introduced, but it increased to 13.1% when related variables were additionally introduced.

Runaway experience increased in those aged 13–16 compared to those aged 17–20 with an odds ratio of 2.20, and drinkers and smokers showed increased runaway experience with an odds ratio of 2.19 and 2.00, respectively. Drinking and smoking, which are delinquent behaviors, influence runaway experiences. Past 12-month alcohol use, and past 30-day cigarette use were all associated with higher odds of running away from home (45), which is consistent with the findings of this study.

Establishing peer groups with adolescents who are engaged in drinking and smoking can lead to runaway behavior and the formation of a runaway family, which can ultimately lead to greater negative consequences (16). It has been reported that interaction with antisocial peers can predict homelessness (31). Therefore, to prevent deviant behavior that can occur in a complex manner emotional support and early intervention are needed for those who already have runaway experiences, in addition to prevention education for smoking and drinking.

Autonomous control ability was determined as an influencing factor for runaway experience as higher autonomous control ability led to a decrease in runaway experience with an odds ratio of 0.76. It has been reported that low autonomous control ability leads to a higher probability of deviant behavior (46), which supports this study's results. It is also consistent with research showing that low levels of self-control are associated with antisocial outcomes (40). Autonomy is the ability to manage and control oneself. Improving and efficiently using autonomous control ability, which allows one to restrict and control one's behavior when exposed to problematic circumstances, will enable one to control one's emotions and behavior and prevent deviance. It will also help establish one's identity and restrict delinquent behavior such as running away from home.

Therefore, emotional support from family and school and the development of an intervention program are required.

Next, the family relationship was statistically significant as a variable affecting runaway behavior. Greater positive relationships with family led to a decrease in runaway behavior with an odds ratio of 0.48. The results of this study are consistent with reports that supportive relationships in families influence runaway behavior among family factors (24). Early adolescents are vulnerable to family conflicts, which can increase the risk of running away from home. It also emphasizes the need to develop primary prevention programs that build healthy relationships between family members during adolescence (31). Numerous factors such as family support, structure, function, and economic characteristics serve as important variables for adolescents' runaway experiences. Hence, reinforcing family

functions such as parental roles is critical. To achieve this, understanding the family characteristics of adolescents, providing parent education programs, and systematic support for vulnerable families are required so that active intervention from parents can prevent their children's runaway behavior. Although adolescents have a strong desire to gain independence from their parents, they need the emotional support of a system within a stable family structure.

Experience of violence was verified as an important factor influencing runaway experience as its increase led to increased runaway behavior with an odds ratio of 1.29. Compared to students living in stable homes, students experiencing homelessness were three times more likely to be threatened or injured with a weapon at school (10). This was supported by a few studies' results (24, 26, 30), which reported that the frequency of runaway experiences increases upon experiencing school violence. The location of violence was mostly inside schools, and the adolescents who reported violence only accounted for 46.5% (2). To escape from violence, adolescents choose to run away from home, and this leads them to a harsher environment as returning home becomes a difficult option. Therefore, to reduce violence, regular counseling and management by school nurses and homeroom teachers, and active intervention by schools are required. They need to investigate violence inside a school, identify victims early, examine the damage, and help their recovery. An intervention program providing coping strategies is also needed.

Finally, the runaway incidents increased according to the experience of exposure to harmful media with an odds ratio of 1.23. As an influencing factor, harmful media exhibited differences according to each type, and this study validated that exposure to harmful media can predict runaway experiences. The environment people live in has been rapidly changing recently due to the prodigious development of media-related technology. Internet and smartphone usage has rapidly increased among adolescents, which has led to the possibility of their exposure to harmful media and the risk of committing sex crimes. Therefore, understanding the characteristics of various types of harmful media and the diagnosis of problems is required (22, 47). For adolescents, who are particularly sensitive to new technology and media use, smartphones have become an important part of their lives (48) as 80.7% of teenagers use the Internet/mobile messenger almost every day, and a 20-year survey showed a steady increase in the number of adult videos marked as not available for adolescents to watch (1).

Prevention programs for internet addiction according to age need to be established. The experience rate of conditional encounter messenger or chat apps is 3.8%, which is slightly higher than in 2016 (1). It is imperative to carefully examine the factors that increase the rate of exposure to new variants of harmful media and prepare countermeasures accordingly.

Therefore, school nurses should include adverse effects of harmful content and preventive management in education programs. In the school setting, there is an urgent need to educate adolescents on harmful media. Health education programs customized for each gender, grade level, and local characteristics, according to their level of internet addiction and the addicted subject, need to be reinforced, so that adolescents recognize the serious risk and negative effects of constant exposure to various harmful media, and are no longer exposed to them.

The uses and gratifications theory suggests that social media (e.g., smartphones) are often used to fulfill one's unmet needs (49). Positive

links were identified between social media and risky behaviors during adolescence in this meta-analysis (50). Hwang et al. (47) found that unsatisfactory family and school environments lead to higher usage of harmful media. This suggests that each variable of family, society, and environment, in addition to individual characteristics, leads to an increased risk of runaway behavior in combination. Therefore, various approaches from an ecological perspective, as well as proper management and regulation, are required for adolescents to comfortably thrive in a healthy media environment.

4.3. Limitations

This study used basic data provided by highly representative raw national data obtained from a nationwide complete enumeration survey on adolescents. However, secondary analysis of the raw data does not allow the use of various related variables based on the literature and cannot change the variables investigated. This study failed to measure related variables in the utilization of development tools whose reliability and validity have been verified. Due to the limitations of the variables, the explanatory power of this study is somewhat low. Juvenile runaway behavior is caused by complex and dynamic processes, so it is necessary to investigate the causes of runaway behavior from multiple perspectives. In this context, this study holds significance as it revealed influencing factors from multilateral aspects of individual, family, school, society, and environmental variables instead of one factor.

Since 2016, the media variable has been included in the harmful environment survey for the first time in South Korea. The 2016 data was analyzed because it was the first meaningful data to include media in the analysis. It is suggested to analyze the longitudinal influence of media on runaways based on the results of media research analysis in 2016 as basic data.

5. Conclusion

Adolescents develop in diverse and complex environmental systems, and individual adolescents are considered part of these systems. In order to minimize youth exposure to harmful environments, social cooperation systems such as school environments, homes, communities, health centers, and social workers should be established to evaluate and mediate the school environment. Acquiring knowledge of the initial data on the community-based runaway incidence and risk factors can provide information to understand the temporal trends of runaway incidence and risk factors in South Korea. This study also empirically validated that harmful media that have recently become diverse and accessible can influence adolescents to run away from home.

This study is also meaningful from the nursing aspect as it highlights the need for health education reinforcement for reducing adolescents' exposure to harmful media. The association of adolescents' runaway experience and emotional impairment such as depression and impulsiveness as individual characteristics, in addition to behavioral factors, needs to be clarified. Moreover, various factors that can affect adolescents' runaway behavior should be further investigated with the inclusion of a wider range of variables. Further studies are also needed on developing early intervention programs that can prevent runaway behavior.

Data availability statement

Publicly available datasets were analyzed in this study. Data are available by request to the Ministry of Gender Equality and Family and National Youth Policy Institute.

Ethics statement

The requirement of ethical approval was waived by Institutional Review Board (IRB) of Chosun University for the studies involving humans because data were from the Korean Survey of (Comprehensive Survey of Adolescents' Contact with Media Usage and Harmful Environment). The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation was not required from the participants or the participants' legal guardians/next of kin because This study is a secondary data analysis of 2016 Comprehensive survey of adolescents' contact with media usage and harmful environment.

Author contributions

HRK: conceptualization, methodology, data analysis, and writing—original draft preparation. S-HM: conceptualization, methodology, writing—review and editing, and project administration. All authors contributed to the article and approved the submitted version.

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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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Social control and self-control: factors linking exposure to domestic violence and adolescents' Internet gaming addiction

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Although many studies have investigated the influencing factors of adolescents' Internet gaming addiction, few have investigated the influence factor of exposure to domestic violence, and even fewer have used the General Strain Theory to explain the influence path of exposure to domestic violence on adolescents' Internet gaming addiction. Based on the GST, this study sought to uncover further insights into the effect of exposure to family violence on adolescents' Internet gaming addiction, and the mediating role of social control—specifically, parental attachment—and self-control in the association between exposure to family violence and adolescents' Internet gaming addiction. Adopting a multi-stage cluster random sampling method, we conducted this study with 2,110 adolescents from Liangshan Yi Autonomous Prefecture in Sichuan Province, China. The results suggest that adolescents' exposure to domestic violence directly affects their addiction to Internet games and indirectly affects it by decreasing social control and self-control. The study not only supplements and improves the explanatory framework of General Strain Theory, but makes a significant contribution to research on the causes of Internet gaming addiction.

KEYWORDS

exposure to domestic violence, Internet gaming addiction, social control, self-control, parental attachment

1. Introduction

According to the 51st Statistical Report on the Development of Internet in China released by the China Internet Network Information Center, as of December 2022, the number of Internet users in China has reached 1.067 billion, an increase of 35.49 million over December 2021, and the Internet penetration rate has reached 75.6% (1). With the rapid popularization of the Internet, the problem of Internet gaming addiction among adolescents has attracted increasing attention. Internet gaming addiction, an important type of Internet addiction (2), involves playing Internet games in uncontrollable, excessive, or forceful ways that result in physical, psychological, and social dysfunction (3). Researchers commonly recognize individuals as demonstrating Internet gaming addictions when they continue to engage in Internet games even though they are aware of the negative effects of their behaviors (4). Internet gaming addiction among adolescents has also received widespread attention because it is often caused

by anxiety, depression, impaired interpersonal relationships, declining academic performance, increased risk behaviors, violent crime, and suicidal behavior (5). Numerous studies have shown that Chinese adolescents demonstrate higher levels of Internet gaming addiction (2.2–21.5%) than their peers in places such as Europe (1.4–9.4%) and the United States (7.6–9.9%) (6–8). Therefore, there is an urgent need to explore the influencing factors of Internet gaming addiction among Chinese adolescents.

The study of children exposed to intimate partner violence (IPV) has accumulated nearly 50 years of research, commencing with the publication of the initial case study in 1975, which provided a comprehensive account of the adverse effects of IPV exposure on children. Then, the primary focus of the research was to identify symptoms in children who were exposed to intimate partner violence (IPV) (9). The findings from the initial cross-sectional studies unequivocally established a robust link between IPV exposure and heightened susceptibility to behavioral, emotional, social, and cognitive difficulties among children (10). Recently, a study using a nationally representative sample of adolescents in China revealed that those who experienced child abuse and/or intimate partner violence (IPV) were considerably more prone to substance misuse, involvement in gambling activities compared to their non-exposed peers (11). However, in the era of widespread Internet access, the relationship between exposure to domestic and Internet gaming addiction remains to be further explored.

In China, the family is generally regarded as the most basic social unit, the most fundamental environment, and the individual's first experiences of social life (12, 13). Parents' words and behaviors and family relationships deeply influence adolescent development (12, 13). At present, many studies have explored the relationship between family factors and adolescents' Internet gaming addiction (14, 15), but only a few studies have specifically explored how exposure to domestic violence impacts Internet gaming addiction. All these studies, without exception, indicate a positive correlation between experiences of domestic violence or exposure to domestic violence and adolescents' Internet gaming addiction (16–20).

However, no studies have yet examined the mechanisms or pathways through which exposure to domestic violence affects Internet gaming addiction. In this regard, General Strain Theory (GST) can provide insights useful for understanding this process. The concept of strain encompasses three types: 1) the deprivation of positively valued stimuli, 2) exposure to negative stimuli, and 3) the inability to attain desired objectives. These strains are believed to induce negative emotions, spanning from anger to depression and anxiety, which in turn drive individuals to seek ways to relieve the associated negative emotions and/or strains (21–23). Agnew points out that even under the same pressure, many people do not choose deviant behavior (21). This is because the tendency to engage in deviant behavior depends on various factors, including personal relationships with parents and friends and personal psychological factors and personality traits (e.g., self-control and self-restraint). Generally, these prerequisite social factors for deviant behavior comprise factors related to the relationship between individuals and society and factors related to the relationship between individuals and themselves. In other words, the presence or absence of these factors can strengthen or weaken the effect of strain on crime. According to the GST, witnessing parental violence can be a strain for adolescents. The likelihood that an adolescent under this pressure will develop an

Internet gaming addiction depends on their relationship with society (social control) and their relationship with their self (self-control).

However, as an adverse life event, the mediating factors linking exposure to domestic violence to the development of Internet gaming addiction, particularly self-control, have not been thoroughly examined. A study in South Korea examined the relationship between domestic violence exposure and Internet gaming addiction as well as the mediating role of social control (parental attachment) (24). However, this study was limited in that it only studied the influence of social control factors (parental attachment) on Internet gaming addiction and not the influence of self-control factors.

Another issue to consider is that despite controlling for negative emotions, the link between strain and crime often persists (25, 26). Additionally, certain studies have found limited or no statistical association between negative affect and criminal behavior (27, 28). Therefore, strain may have a direct effect on criminal behavior. Meanwhile, compensation theory notably suggests that unfulfilled satisfaction in one domain can be compensated by satisfaction in another domain (29). Adolescents who experience or witness domestic violence in long-term family life are likely to experience insecurity and emotional disorders. Considering that adolescents are often in a disadvantaged and powerless position in the family system, they are more likely to engage in Internet games to easily experience control and satisfaction; however, this can lead to Internet gaming addiction. Along these lines, several empirical studies have shown that adolescents who are exposed to aggressive dialog and, relatedly, hostility between parents are more likely to become addicted to Internet games (16–18). For example, Zhao's study suggests that adolescents exposed to domestic violence have a higher risk of Internet gaming addiction compared to other adolescents, and the more an adolescent experiences domestic violence, the higher their risk of developing an Internet gaming addiction (19). In addition, this study also showed that exposure to domestic violence directly increases Internet gaming addiction (20).

However, previous studies on this topic have mostly focused on adolescents from South Korea; investigations of Chinese samples, especially those from underdeveloped ethnic minority areas, are lacking. Liangshan Prefecture is the largest settlement area for the Yi ethnic group in China, with a total population of 5.3825 million, among which the Yi people account for 54.56%. It is the region with the highest ethnic diversity and the largest population of ethnic minorities in Sichuan Province, China (30). A study conducted in Yunnan Province, China, revealed a higher prevalence of severe alcohol consumption in Yi families compared to Han families (31). Excessive alcohol consumption has been associated with a higher likelihood of domestic violence against women (32). Furthermore, research indicates that domestic violence is prevalent in Yi families in Liangshan Prefecture, with women often bearing the brunt of such violence, leading to a higher probability of children being exposed to domestic violence compared to other regions (33). Historically, Liangshan Prefecture has been a typical case of severe regional poverty in China, characterized by a large impoverished population, deep-rooted poverty, and complex poverty factors (30). Due to relative economic deprivation, a considerable number of parents in Liangshan Prefecture choose long-term labor migration, resulting in a significant population of left-behind children in rural areas. These left-behind children often lack appropriate parental supervision. Combined with the shortage of qualified teachers, low efficiency of family education,

and limited school-home collaboration, children in Liangshan Prefecture are more susceptible to Internet gaming addiction (34, 35).

In response, this study examined the influence of exposure to domestic violence on adolescents' Internet gaming addiction through samples from ethnic minority areas in China and considered the mediating roles of social control and self-control to verify whether GST applies to adolescents' Internet gaming addiction.

Before further detailing the study, it is necessary to first establish why social control and self-control are important elements to consider when exploring the associations between exposure to domestic violence and adolescents' Internet gaming addiction. As discussed above, GST suggests that good social control can inhibit deviant behavior under strain; accordingly, social control is a technique and strategy to prevent deviant behavior (36). Specifically, social control refers to a mechanism that regulates individual and group behavior to make people comply with the rules of a specific social group (37). Hirschi, the leading voice of social control theory, believes that social control mainly consists of four concepts: attachment, commitment, involvement, and belief. Among these, "attachment" refers to the degree of dependence and intimacy between individual and social network members (e.g., parents, partners, relatives, friends), which plays the most crucial role in the process of restraining individual bad behaviors (38).

The attachment paradigm may explain the relationship between early exposure to parental violence and parental attachment (39, 40). Many studies have reported data supporting the possible destructive impact of childhood exposure to parental violence on parental attachment. For example, in a study by Sausa et al. (41), adolescents exposed to domestic violence during childhood felt more alienated from their parents than other adolescents. Children exposed to parental violence and neglect are more likely to develop insecure attachment styles than non-exposed children (42, 43). Research by Markiewicz shows that ambivalent perceptions of parents and restless attachment present a static correlation and that witnessing hostility between parents can damage the stability of attachment (44). Unstable attachments to parents are also related to adolescents' addiction to Internet games. Seob showed that if adolescents' parents have poor relationships or they have experienced domestic violence, they tend to spend more time using the Internet and smartphones and have a higher risk of becoming addicted to Internet games (45). A series of studies in South Korea have shown that the lower the stability of attachment to parents, the higher the risk of Internet addiction and gaming addiction among adolescents (46–48). These existing studies suggest that parental attachment plays a mediating role in the relationship between exposure to domestic violence and adolescents' Internet gaming addiction. This also has been explored in previous studies. For example, Dukanac et al. (49) found that exposure to domestic violence indirectly affected addiction through a decrease in parental attachment.

Meanwhile, self-control is an important psychological function by which individuals actively control unreasonable thoughts, emotions, and behaviors to conform to social norms and achieve long-term goals (50, 51). Previous studies have found that individuals with high levels of self-control can better control and suppress negative behavioral responses. Conversely, a lack of self-control can affect an individual's executive control function, leading to irrational decision-making (52, 53). Agnew stated that self-control may be the most potent factor affecting the relationship between strain and aggressive behavior (22).

The formation of self-control in adolescents is related to parenting practice and parental self-control. Gottfredson and Hirschi argue that parents with low self-control are likely to be ineffective at parenting and produce children with lower self-control (54). Meldrum et al. (55) provide evidence of an indirect association between maternal self-control and early childhood self-control through maternal ineffective parenting. Considering that exposure to domestic violence implies that parents have a lower level of self-control, which can affect adolescents' self-control, we can infer that exposure to domestic violence is a predictive factor for adolescent self-control.

For our purposes, it is important to remember that a lack of self-control is closely related to Internet gaming addiction. Multiple studies have shown a significant relationship between self-control and Internet gaming addiction. The weaker the individual's self-control, the more likely they are to develop an Internet addiction (56–59). Faced with the stimulation and temptation of the virtual network world, individuals with high levels of self-control can rationally regulate their network use and will not overindulge in the pleasure brought by the network. In contrast, individuals with low levels of self-control will find it difficult to extricate themselves from the virtual world, and even use it to escape real-life problems (60). Therefore, considering the theory of self-control and empirical studies on the relationship between domestic violence exposure, self-control, and Internet game addiction, we propose that self-control may play a mediating role between exposure to domestic violence and adolescent addiction to Internet games.

Based on the overall framework of GST, this study examined the impact and pathway of exposure to domestic violence (strain) on Internet gaming addiction (deviant behavior). Unlike previous studies, we proposed that exposure to domestic violence leads to adolescent Internet gaming addiction not only by reducing social control (parental attachment), but also by weakening self-control. With reference to the literature, we proposed the following hypotheses:

1. Exposure to domestic violence positively predicts adolescents' Internet gaming addiction.
2. Exposure to domestic violence positively predicts adolescents' Internet gaming addiction through the mediating role of social control.
3. Exposure to domestic violence positively predicts adolescents' Internet gaming addiction through the mediating role of self-control.

2. Method

2.1. Participants

Adopting a multi-stage cluster random sampling method, this study recruited 2,110 adolescents (grades 7–8) attending five secondary schools in Liangshan Yi Autonomous Prefecture, Sichuan Province, China. As shown in Table 1, there were 987 boys and 1,123 girls in the sample, with an average age of 14.70 years old (range 7–18 years). The family economic status of most participants was low- or middle-income, and many of the participants' parents did not attend or finish primary school. The study was approved by our university's research ethics committee, and all respondents were informed of their rights of informed consent, voluntary participation, anonymity, and confidentiality. In the analysis, multiple imputations were adopted to handle missing values.

TABLE 1 Descriptive statistics of the participants.

	Frequency (n)	Percentage (%)
Gender		
Boy	987	46.8
Girl	1,123	53.2
Age	M = 14.70 (years)	Range = 7–18 (years)
Grade		
Grade 7	1,141	54.1
Grade 8	969	45.9
Family economic status		
Very poor	242	11.5
Poor	962	45.6
Middle-class	886	42.0
Wealthy	15	0.7
Very wealthy	5	0.2
Father's/mother's highest level of education		
Did not attend or finish primary school	1040/1522	49.3/72.1
Primary school	730/403	34.6/19.1
Secondary school	273/146	12.9/7.0
High school	43/14	2.1/0.6
Vocational college	15/20	0.7/1.0
Junior college	8/4	0.4/0.2
Bachelor's degree or higher	1/1	0.0/0.0

2.2. Measures

Exposure to domestic violence was measured with three items assessing how often adolescents witness conflict between their parents. Each item was rated on a 5-point Likert scale ranging from 1 (*never*) to 5 (*always*), with higher scores representing more exposure to domestic violence. Representative items included “I have witnessed my family being loudly scolded, insulted, or humiliated by other family members” and “I have witnessed my family being slapped, kicked, punched or beaten by other family members.” The reliability of the scale was found to be acceptable for the participants in this study (Cronbach's $\alpha = 0.66$).

Social control was measured by the Parental Attachment subscale taken from a revised version of Hirschi's Bonding Scale (61). This subscale contains four items, such as “I talk over future plans with my parents” and “I share my thoughts and feelings with my parents.” Participants responded to each item on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). In analysis, the four items were reverse coded, with higher scores representing less social control from parents. In our study, Cronbach's alpha for the instrument was 0.72.

Self-control was measured by the Temper subscale taken from Grasmick et al.'s Self-control Scale (62). This subscale contains four items following a 4-point Likert-type scale, ranging from *strongly disagree* to *strongly agree*. Higher scores on the scale indicate a higher likelihood of becoming angry and lower levels of self-control.

Representative items included “I lose my temper easily” and “When I am angry at people, I feel more like hurting them than talking to them about why I am angry.” The original version of the scale has demonstrated good explanatory power in a sample of Chinese adolescents (63), and the Cronbach's alpha for the Temper subscale in our study was 0.70.

Internet gaming addiction was measured by the Internet Gaming Disorder Scale-Short Form (64), which comprises nine items assessing the degree of individuals' addiction to Internet gaming. All the nine items were rated using a 5-point Likert-type scale (1 = *never* and 5 = *very often*), with a higher score on the scale indicating a higher risk of developing an Internet gaming addiction. Representative items included “Do you systematically fail when trying to control or cease your gaming activity?” and “Do you feel the need to spend increasing amounts of time engaged in gaming in order to achieve satisfaction or pleasure?” The nine-item scale has previously been validated with promising psychometric properties in English, Italian, Turkish, Persian, Portuguese, Albanian, and Chinese samples (65). The Cronbach's alpha for the scale in our study was 0.87.

Covariates. In the analysis, gender (1 = *boy*, 2 = *girl*), age, and family socioeconomic status (SES; assessed by parents' highest level of education and family economic status) were included as control variables.

2.3. Data analysis

Preliminary analyzes, including mean scores, standard deviations, and bivariate correlation, were performed using SPSS 24.0. The measurement model and structural equation modeling were conducted in AMOS 26.0 to test the factor loadings, model fits, and the direct and indirect effects between variables. The indirect effects were also confirmed by performing bootstrapping analyzes with 5,000 resamples and 95% bias-corrected confidence intervals. In addition, multiple indices were used to determine whether the models fit the data well, including Chi-square divided by degrees of freedom (χ^2/df , 3–6 acceptable), the comparative fit index (CFI, >0.90 acceptable), and the root mean square error of approximation (RMSEA, <0.08 acceptable) (66).

3. Results

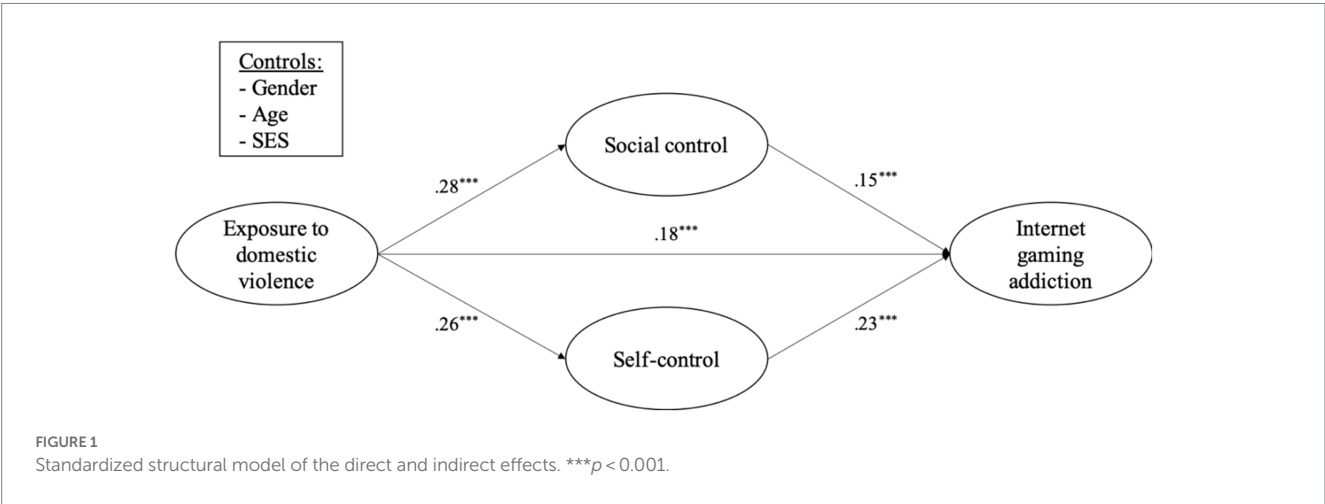
3.1. Descriptive and correlations

Mean scores, standard deviations, and bivariate correlations of all variables are presented in Table 2. As shown, the primary variables were significantly correlated with each other in the expected directions. In particular, exposure to domestic violence was positively correlated with social control ($r = 0.186$, $p < 0.01$), self-control ($r = 0.183$, $p < 0.01$), and Internet gaming addiction ($r = 0.223$, $p < 0.01$). Meanwhile, both social control ($r = 0.196$, $p < 0.01$) and self-control ($r = 0.255$, $p < 0.01$) were significantly correlated with Internet gaming addiction. Moreover, the control variables were significantly correlated with some of the primary variables. The direct effect of exposure to domestic violence on Internet gaming addiction was also examined, and the results indicated that exposure to domestic violence was significantly associated with higher levels of Internet gaming addiction among the adolescents in the study ($\beta = 0.27$, $p < 0.001$).

TABLE 2 Bivariate correlation between variables.

	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7
1. Exposure to domestic violence	1.27	0.50	1						
2. Social control	2.43	0.93	0.186**	1					
3. Self-control	1.91	0.66	0.183**	0.141**	1				
4. Internet gaming addiction	1.44	0.61	0.223**	0.196**	0.255**	1			
5. Gender	1.53	0.50	−0.027	−0.017	−0.019	−0.329**	1		
6. Age	14.7	1.2	0.059**	0.015	−0.002	−0.043*	0.045*	1	
7. SES	0.69	0.19	−0.070**	−0.044*	0.001	0.066**	−0.126**	−0.185**	1

** Significant at the 0.01 level (2-tailed).
* Significant at the 0.05 level (2-tailed).



3.2. Test of the measurement and structural models

We performed the measurement model with four latent variables. The results showed a good fit to the data: $\chi^2 = 899.685$, $df = 164$, $\chi^2/df = 5.486$, $p < 0.001$; CFI = 0.943; RMSEA = 0.046; SRMR = 0.035. All the factor loadings for the indicators on the latent variables were significant at the $p < 0.001$ level. The factor loadings of exposure to domestic violence, social control, self-control, and Internet gaming addiction ranged from 0.532–0.777, 0.356–0.763, 0.525–0.680, and 0.556–0.798, respectively. The results indicated that the observed indicators effectively represented their latent variables.

The test of the hypothesized structural model with mediators also showed that the sample provided a good fit to the data ($\chi^2 = 1252.532$, $df = 219$, $\chi^2/df = 5.719$, $p < 0.001$; CFI = 0.923; RMSEA = 0.047; SRMR = 0.038). A total of 26.6% of the variance in adolescents' Internet gaming addiction was explained by the model. Figure 1 and Table 3 show the estimates of the structural model and bootstrapping results of the direct and indirect effects. As hypothesized, the results revealed significant indirect effects of exposure to domestic violence on adolescents' Internet gaming addiction *via* social control (95% CI: [0.044, 0.133], $\beta = 0.080$, $p < 0.001$). Specifically, exposure to domestic violence was positively associated with social control ($\beta = 0.28$,

$p < 0.001$), which further increased adolescents' Internet gaming addiction ($\beta = 0.15$, $p < 0.001$). Exposure to domestic violence also had a significant indirect effect *via* self-control on adolescents' Internet gaming addiction (95% CI: [0.072, 0.175], $\beta = 0.113$, $p < 0.001$). Specifically, exposure to domestic violence was positively associated with self-control ($\beta = 0.26$, $p < 0.001$), which further increased adolescents' Internet gaming addiction ($\beta = 0.23$, $p < 0.001$).

Apart from the significant indirect effects, exposure to domestic violence also demonstrated a significant direct effect on Internet gaming addiction (95% CI: [0.104, 0.262], $\beta = 0.180$, $p < 0.001$) in the structural mediation model. This means that social control and self-control partially mediated the relationship between exposure to domestic violence and adolescents' Internet gaming addiction. Of all the control variables, only gender was significantly associated with Internet gaming addiction ($\beta = -0.32$, $p < 0.001$), indicating that boys were more likely to be addicted to Internet gaming than girls.

4. Discussion

Based on GST, we explored how social control (parental attachment) and self-control mediate the effect of exposure to family violence on adolescents' Internet gaming addiction by studying a

TABLE 3 Estimates of the structural model and bootstrapping results of the direct and indirect effects.

Estimates of the structural model	B	β	SE	CR	p
Exposure to domestic violence → Internet gaming addiction	0.342	0.18	0.055	6.240	***
Exposure to domestic violence → Social control	0.766	0.28	0.086	8.939	***
Exposure to domestic violence → Self-control	0.455	0.26	0.059	7.724	***
Social control → Internet gaming addiction	0.104	0.15	0.017	5.943	***
Self-control → Internet gaming addiction	0.247	0.23	0.029	8.412	***

Bootstrapping results of the direct and indirect effects	β	SE	p	95%CI	
				Lower	Upper
Direct effect					
Exposure to domestic violence → Internet gaming addiction	0.180	0.040	0.000	0.104	0.262
Specific indirect effect					
Exposure to domestic violence → Social control → Internet gaming addiction	0.080	0.022	0.000	0.044	0.133
Exposure to domestic violence → Self-control → Internet gaming addiction	0.113	0.026	0.000	0.072	0.175
Total effects	0.282	0.035	0.000	0.214	0.355

****p* < 0.001.

sample of 2,110 adolescents from Sichuan Province, China. Initially, we proposed that the adolescents' exposure to domestic violence would directly affect their addiction to Internet games and, additionally, indirectly affect their addiction by decreasing their social control and self-control.

4.1. Relationship between exposure to domestic violence and addiction to Internet games

The results revealed that exposure to domestic violence positively predicts adolescent Internet gaming addiction. This result is consistent with most previous research, which reports significant and positive relations between exposure to domestic violence and Internet gaming addiction (19–21, 24, 29). These findings have been explained by the social compensation model. Children exposed to parental violence are more likely to have insecure attachments with their parents (42, 43). Positive experiences for adolescents immersed in Internet gaming could compensate for poor parent–child relationships, which can lead to pathological Internet use (67). Meanwhile, the findings of this study demonstrate a direct effect of strain on deviant behavior, providing new insights into the GST. At present, there are few studies on the relationship between exposure to domestic violence and Internet gaming addiction, and most of them feature Korean samples. The current study was based on samples from ethnic minority areas in China and therefore further enriches the relevant empirical research.

4.2. The mediating role of social control

The results revealed that exposure to domestic violence had a significant indirect effect on adolescents' Internet gaming addiction *via* social control. Specifically, exposure to domestic violence was

positively associated with social control, which further increased adolescents' Internet gaming addiction. This result was consistent with the previous research in Korea that found that parental attachment had a mediating effect on the relationship between exposure to domestic violence and Internet gaming addiction (24). Social control theory can be used to explain this result. According to this theory, individuals obey rules because of social control (68)—while there is a potential deviant motivation in everyone's human nature, individuals do not engage in deviant behavior because of effective social control (37). Therefore, we may consider that while every adolescent is a potential addict, some do not have Internet gaming addictions because they developed connections with multiple subjects, including parents, during their socialization process, which effectively controls their Internet usage behavior.

Interestingly, different findings have emerged regarding the relationship between exposure to domestic violence and parental attachment. For example, an Israeli study suggested that domestic violence had distinct effects on children's perception of their relationships with their parents that differed depending on whether the children were themselves victims of that violence. Notably, the study reported that witnessing spousal abuse had little impact on children's perceived relationships with their parents (69). However, a study in South Korea found that parental attachment completely mediates exposure to domestic violence and Internet gaming addiction (24), which reflects the significant utility of parental attachment. The results of this study suggest that children in East Asian countries may be more sensitive to the interaction patterns of their family members. Especially within Yi culture, individuals are not seen as independent entities but rather as integral members of their extended families. Close interaction among family members constitutes the most significant and primary relationships (70). Consequently, Yi children exhibit heightened sensitivity to the quality of family relationships, which may explain how witnessing family violence can undermine their attachment to their parents.

4.3. The mediating role of self-control

The results revealed that exposure to domestic violence also had a significant indirect effect *via* self-control on adolescents' Internet gaming addiction. Specifically, exposure to domestic violence was positively associated with self-control, which further increased adolescents' Internet gaming addiction. To some extent, this finding is consistent with the results of previous studies. In real life, long-term exposure to domestic violence can cause pain, anxiety, depression, and insecurity, while consuming self-control resources. When the self-control protection system cannot be restored promptly, the ability to practice self-control will decrease (71–73). Compared to adults, adolescents have weaker self-control abilities, so when they are exposed to Internet games, they are prone to exceeding their reasonable usage time, leading to Internet gaming addictions. As Meldrum et al. surmised, children and adolescents with parents with lower levels of self-control and closely related personality traits are more likely to be exposed to less nurturing family environments, to have lower levels of self-control themselves, and to engage in antisocial behavior (55). In Yi society, parental role modeling plays a paramount role in the socialization of children. A plethora of proverbs in Yi daily life expound upon the influence of parents in shaping their children's behavior patterns, such as "Parents who speak kindly teach children to be courteous," "When mothers steal salt, daughters will steal chili," and "Parents behaving uncivilly lead to coarse language in their children" (74). These expressions underscore the significance of family atmosphere in influencing children's behavioral patterns. Exposure to family violence is perceived as a manifestation of parental lack of self-control, which in turn affects the self-control abilities of the children and consequently increases the likelihood of Internet gaming addiction.

There is limited research on the mediating role of self-control in domestic violence exposure and Internet gaming addiction. This study can guide future research on the role of self-control in regulating strain and deviant behaviors in GST. For example, future research can apply this study's model to other explanations of deviant behavior. In addition, the results also notably revealed that boys are more likely to become addicted to Internet games than girls, which is consistent with previous studies (75, 76).

5. Contributions, limitations, and future directions

This study makes several contributions to existing research and practice. Notably, this study incorporated social control theory and self-control theory into the framework of GST, formed a new explanatory model for deviant behavior, and verified this model. GST explains how experiencing strain leads to deviant behaviors such as crime. This study applied GST to explore how children develop Internet gaming addiction after experiencing exposure to domestic violence. Previous studies on the application of GST only considered the mediating factors of social control in strain and deviant behavior (49, 77). This study expanded the theory's application scope to Internet gaming addiction. The results show that exposure to domestic violence can predict adolescent Internet gaming addiction through the mediating effects of social control and self-control. These findings evidence that, under strain, adolescents will demonstrate less social

control and self-control, which increases their risk of deviant behavior. The study not only supplements and improves the explanatory framework of GST, but makes a significant contribution to research on the causes of Internet gaming addiction.

Additionally, the results of this study provide ideas for practice on how to address adolescent Internet gaming addiction, especially in Yi society. Considering the impact of exposure to domestic violence and parental attachment on adolescents' addiction to Internet games, the study emphasizes that preventive measures are necessary; for example, parents should be encouraged to avoid conflicts in front of their children and to maintain good relationships with their children. Meanwhile, social work intervention projects with the theme of self-control should be further valued and implemented to prevent and solve the problem of adolescent Internet gaming addiction. Considering the scarcity of professional social services in Yi areas, local governments may contemplate introducing specialized social organizations to implement such practices in order to reduce domestic violence and enhance self-control among adolescents.

This study also has some limitations. First, because a cross-sectional design was employed, no causal inferences were determined. Future studies could use experimental designs to further verify the results of the present study. Second, this study's sample only included adolescents from poverty-stricken areas in China, which may limit the generalizability of the results; therefore, future studies could use other samples in China or other countries to verify the current results.

6. Conclusion

This study offers three conclusions. First, exposure to domestic violence has a significant direct effect on adolescents' Internet gaming addiction. Second, exposure to domestic violence has a significant indirect effect on adolescents' Internet gaming addiction *via* social control. Specifically, exposure to domestic violence was found to be positively associated with social control, which further increased adolescents' Internet gaming addiction. Third, exposure to domestic violence also had a significant indirect effect *via* self-control on adolescents' Internet gaming addiction. In particular, exposure to domestic violence was positively associated with self-control, which further increased adolescents' Internet gaming addiction. In addition, the study also found that boys are more likely than girls to develop an Internet gaming addiction.

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 Research Institute of Social Development Southwestern University of Finance and Economics. 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

LQ, project leader, is responsible for data collection and participating in paper writing. CM is responsible for the primary writing, polishing, revision, and submission of the paper. CK is responsible for data collection, data analysis, and participating in paper writing. All authors contributed to the article and approved the submitted version.

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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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Wellbeing, social media addiction and coping strategies among Chilean adolescents during the pandemic

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Introduction: During the COVID-19 pandemic, adolescents had to deal with a range of mental health problems that has increased social media addiction levels with adverse effects on life satisfaction. Previous studies have explored coping mechanisms to deal with this addiction problem, but did not consider the need to simultaneously cope with different dimensions. Therefore, our study aimed to examine the moderating effect of various coping mechanisms on the relationship between social media addiction and adolescent life satisfaction.

Methods: Self-report questionnaires were applied to 1290 secondary school students (age mean = 16.03, $SD = 1.27$, range: 14 to 19; and 57% female). An exploratory and a confirmatory factor analysis were performed to determine the factor structure of the Brief-Cope 28 scale. Then, a descriptive and correlational analysis of the variables and a multiple linear regression analysis was performed.

Results: We found that the social media addiction risk was negatively associated with life satisfaction, adaptive strategies were positively correlated to life satisfaction, and maladaptive strategies were negatively correlated to it. Also, a moderation model was evaluated in which four stress management strategies, namely acceptance and perspective-taking, seeking socio-emotional support, active coping, and maladaptive strategies all conditioned the relationship between social media addiction risk and life satisfaction after controlling for demographic variables and the specific strategies of using comedy, religion and substance use. Results indicate additive and multiplicative effects of management strategies for stressful situations in the studied relationship. Seeking socio-emotional support and active coping were positively related to life satisfaction and maladaptive strategies were negatively associated with it. Multiplicative effects indicate that the relationship between the social media addiction risk and life satisfaction depends only on the acceptance and perspective taking that adolescents report. When adolescents reported having low or average levels of acceptance and perspective taking, there was a negative correlation with general life satisfaction, a connection that grew markedly stronger. In contrast, no connection between social media addiction and life satisfaction was detected for adolescents who report higher levels of acceptance and perspective-taking.

Discussion: Abuse of social media and the use of maladaptive stress coping strategies were risk factors that decreased life satisfaction among adolescents during the COVID-19 pandemic period.

KEYWORDS

wellbeing, life satisfaction, social media addiction, adolescents, coping, COVID-19

Introduction

Wellbeing is an important aspect of mental health among adolescents. Yet, during the pandemic they had to face new risk factors with negative consequences, especially for their mental health. One risk factor, due the increasing need to connect to others online, was the heightened level of social media addiction among adolescents. Increased levels of social addiction can have negative consequences in the short and long term for mental health, which became more negative during the pandemic, considering the long hours spent online during this period. In such a context, recognizing individual capacities for handling negative consequences is vital for prevention among adolescents, including developing coping strategies to deal with stress. Even though previous studies have recognized the importance of coping strategies for adolescents' mental health, they have not examined the possible protective effect coping can have, attenuating the negative effect of social media addiction on adolescent wellbeing. Therefore, the purpose of the study was to examine this relationship with Chilean adolescents during the pandemic.

Social media addiction, wellbeing, and life satisfaction among adolescents

Subjective wellbeing is increasingly being considered as a central component of mental health and a determining element for a positive life for children and adolescents, as a key component of positive psychology framework (1). In turn, life satisfaction is a global cognitive evaluation that a person makes of his or her quality of life. It is also one of the key components of subjective wellbeing (2, 3), being different but highly correlated constructs.

In general, various countries around the world report high levels of wellbeing and life satisfaction during childhood and adolescence, based on a positive psychology framework. For example, one study that included data from 128,000 children between 8 and 12 years of age from 35 different countries found that they reported high satisfaction with their lives, especially in the life domains related to family and home (4). Similar results have been found in Chile, also reporting high levels of wellbeing and life satisfaction in this population (5). During the pandemic, however, life satisfaction levels significantly decreased (6).

For example, globally, an umbrella review that included 17 systematic reviews of studies on the effect of the pandemic on adolescent mental health found that adolescents had higher levels of depression, anxiety, sleep disorders, stress-and trauma-related disorders, suicidal ideation, attention disorders, and general mental health problems compared to levels before the onset of the pandemic (7), negatively affecting wellbeing and life satisfaction. Similarly, a study conducted in Chile that evaluated satisfaction with life among other variables and the experiences of adolescents during the pandemic period reported that adolescent mental health was disturbed, introducing higher levels of worry, fear and nervousness in this group with lower levels of energy, happiness and confidence compared to the time before the COVID-19 pandemic (8).

Studies have shown that life satisfaction has been strongly associated with mental health self-report (9). Specifically, life satisfaction during adolescence has been linked to variables such as

self-esteem, perceived social support, emotional stability, interpersonal competencies among others (10, 11).

Moreover, factors such as substance abuse, aggressive behaviors, poor parental relationships, increased victimization, depressive mood, and social media addiction and several others have been found to function as risk factors for life satisfaction of children and adolescents (6, 12–14).

Specifically, social media addiction has been found to constitute an important risk factor for adolescents' life satisfaction (15). Despite advances in understanding the relationship between life satisfaction and social media addiction during adolescence, there is still a lack of data to clarify this relationship in the context of the pandemic.

Social media addiction among adolescents during the pandemic

The WHO formally declared the COVID-19 infection to be epidemic around the world in 2020 (16), which had negative effects for adolescents worldwide (17). During this period, internet use increased significantly with possible negative effects on adolescents. For example, Marciano and colleagues (18) conducted a systematic review of 30 studies that had been published up to September 2021 about the relationship between the mental health and digital media use of adolescents during COVID-19, demonstrating a positive correlation with media addiction and ill-being. Likewise, a review regarding the effect of social media use on mental health during the pandemic in the adolescent population reported an increased use of screens during the first year of the pandemic, which negatively impacted adolescent mental health (19).

Today's adolescents are known as "digital natives" as they have been exposed to the use of digital platforms and related technologies from an early age (18). Social networks, mobile messaging, and microblogging services like Twitter, Tik Tok, Mastodon, Facebook, WhatsApp, Messenger, Instagram, YouTube, LinkedIn, Reddit, Snapchat, Amino, Signal, Telegram, WeChat and others are established information media, especially among adolescents (20). At a younger age, platforms are used for social and entertainment purposes. As age increases, they begin to get used for accessing information and educational material (21). Adolescents use these media as one of their primary ways of interacting and directly communicating with other people, generating a sense of belonging in their social lives (22).

Social network use has grown steadily worldwide, which saw a significant jump during the pandemic, growing by 13% between January 2020 and January 2021 with 490 million new user accounts (23, 24). In Chile, approximately 17.85 million users are active on social networks, representing 92.8% of the national population. The number stands at 227 million worldwide after growing by 5% in 2022, equivalent to 59% of the world population (24). When we look at adolescents in Chile, we see that 88% have a fixed broadband connection at home and 81% have a cell phone. Due to such widespread use, more than 50% acknowledge that they have less time for engaging in other activities (studying, playing sports, spending time with family) because of being online for so long; 58% for those under 12 years of age and 54% for above 12 years of age.

Despite all the benefits related to using the Internet and social media, especially during the pandemic period, since it frequently enabled the continuation of classes or meetings and facilitated contact

with family and friends, the indiscriminate and unsupervised use of this technological tool also brought negative consequences. According to the literature, the negative influence of the Internet and social media on mental health and specifically on life satisfaction had been reported even before the onset of the pandemic; however, during this period its influence grew even more significant (19). Specifically, a peer review that looked at the effects of the pandemic on adolescent mental health reported that one of the negative consequences associated with indiscriminate internet use is social media addiction, among other consequences (7).

Social media addiction refers to the excessive and uncontrollable need to get online and is one of the most worrying current public health issues, especially among adolescents (25). In the last decade several terms have been used to describe this behavior such as “compulsive computer use,” “internet dependence,” “pathological internet use,” and “internet addiction” (26). Studies prior to the pandemic had placed the prevalence of social media addiction in ranges varying from 3 to 17% (27, 28). In contrast, studies conducted during or after the COVID-19 pandemic period report increased prevalence, ranging from 19 to 22% (25, 29). Therefore, more studies exploring the effect of social media addiction in the recent past are needed.

Although the concept of social media addiction was not included in the DSM-5 as a disorder, social media addiction is a global and widely-recognized problem (30). There are both emotional and physical characteristics of social media addiction, including mental health problems, lack of patience, isolation, disruption of social relationships, weight loss or weight gain, vision problems, poor nutrition, insomnia, and more (31). Numerous risk factors for social media addiction have been associated at the individual, family, relational, school and community levels (32, 33), reporting specific risk factors such as impulsivity, neuroticism, depression, anxiety, low family support, family dysfunction, and more.

Despite the numerous studies that have been conducted to better understand social media addiction, few have tried to understand the factors that protect against social media addiction. For example, a meta-analysis of 153 studies identified 56 risk factors for social media addiction and only 28 protective ones (32). Although progress has been made around identifying protective factors associated with coping strategies used by adolescents, not enough is known given the fact there are multiple types of strategies that can be both adaptive and maladaptive and may interact and relate differently when it comes to social media addiction (34, 35).

Coping mechanisms as protective factors

Coping strategies are understood as complex cognitive, emotional and behavioral mechanisms that people use to cope with various adverse and stressful situations in order to reduce the negative consequences (36). These types of skills are of vital importance due to their effects on the interpersonal, family and psychosocial functioning of the population, especially during adolescence since this is a critical development period (37).

Several studies show that coping strategies are a fundamental resource for stress management situations and various difficulties, since the strategies determine the degree of problem resolution and their effects on quality of life and life satisfaction (38). In addition,

we see that adaptive coping is associated with better mental health and life satisfaction outcomes, as well as lower levels of perceived stress, being a key resource for the optimal functioning of individuals in the face of adverse and highly stressful situations (39).

Previous studies show that adaptive coping strategies are a key resource as a protective factor of life satisfaction against the negative effects of perceived stress in adult and adolescent populations (40). We see also that when dealing with addiction, cognitive coping focused on problem-solving is a protective factor for mental health as well as for positive interpersonal relationships and reducing addictive symptoms (39, 40). Moreover, we see that maladaptive coping skills like denial and self-incrimination are risk factors that increase the risk of depression and suicide while reducing levels of life satisfaction in the population with addiction problems (41).

The COVID-19 pandemic period showed that coping strategies are a key resource for managing its negative effects; however, due to the prolonged effect and variability of coping strategies, many negative effects on wellbeing and an increased risk of addiction were detected in the population (42). Thus, cognitive and problem-focused coping strategies have been found to mitigate the negative impact of pandemic-related stressors on adolescents' wellbeing levels (42). Nevertheless, there is little evidence on coping strategies and social network addiction in the adolescent population from the pandemic period.

Therefore, based on previous revision, we recognize that life satisfaction can be affected by social media addiction as a significant risk factor for adolescent mental health. Yet, we can recognize individual resources that can moderate this negative effect by becoming protective factors. Therefore, the study's aims were: (1) To examine the effect of social media addiction on adolescent wellbeing. (2) Examine the positive effect of coping mechanisms on adolescent life satisfaction. (3) Test the interaction effect of coping mechanisms on the relationship between social media addiction on life satisfaction. Based on a prior review, we hypothesized that internet addiction would be negatively correlated with adolescent life satisfaction. We also hypothesized that coping mechanisms would have a moderating effect on this connection. More specifically, more and better coping mechanisms would ameliorate the negative effects of internet addiction on adolescent life satisfaction.

Methodology

Sample

A total of 1,320 students participated in the study; 57% were female ($n = 753$) aged 14–19 ($M = 16.03$ years, $SD = 1.27$). The students were in secondary school (grades 9–12), including nine private and public schools in three regions of Chile (Santiago the Metropolitan, Los Rios, and Bio Bio Regions). Schools were selected through convenience sampling.

Data collection

The self-report questionnaire was applied online from April to July 2021, when major mobility restrictions and population confinement measures were implemented. In addition, during this

period school children had to attend classes online due to the COVID-19 pandemic and school closures ordered by the Chilean Government. Data production was carried out by coordinating with each educational establishment, having first sent passive informed consent forms to the instructors and informed assent forms to the students.

Each data collection activity averaged 45 min in duration and was carried out by the research team during regular school hours by sending the questionnaire access link available on the Alchemer Survey platform. The project was approved by the Ethics Committee of the Universidad del Desarrollo de Chile. After obtaining informed consent from the teachers, students were required to sign an informed assent form before participating. They were not given any incentives for their participation.

Instruments

Student life satisfaction scale

This instrument was developed by Huebner (43) for measuring global satisfaction with life in children and adolescents aged 8 to 18 years. This scale has been validated in Chile and shown to have adequate psychometric properties in Chilean children and adolescents (43, 44). An abbreviated four-item version was used for the present study, which assesses several measures of life satisfaction through an 11-point Likert-type response scale (0 = Strongly disagree; 10 = Strongly agree), which includes the following statements: “My life is going well,” “My life is the way I want it to be,” “I have a good life” and “I have what I want in life.” Higher scores on the scale indicate higher levels of life satisfaction. The reliability coefficient for our study’s sample was $\alpha = 0.902$.

The Bergen social media addiction scale

The Bergen social media addiction scale (BSMAS) is a six-item instrument developed by Andreassen et al. (45) to assess the risk of social network addiction, adapted from the Bergen Facebook Addiction Scale (BFAS). It was translated into Spanish using translation and back-translation methodology (46). The scale was developed based on the six core components of addiction proposed by Kircaburun et al. (21) (i.e., salience, mood modification, tolerance, withdrawal conflict, and relapse). The instrument uses a five-point Likert-type scale ranging from very rarely (1) to very often (5). A higher score on the BSMAS is associated with a higher risk of social network addiction. Item examples: “How often during the last year have you felt an increasing need to use social networks?”; “Have you tried to stop using social networks and were not able to?”; “Have you used social networks so much that their use has negatively affected your work/studies?” The unidimensionality and satisfactory psychometric properties of the BSMAS have been confirmed in different languages in diverse populations (45, 46), including English, Italian, Persian, and Portuguese. The higher the score, the higher the self-report of addiction levels. The reliability coefficient for our study’s sample was $\alpha = 0.813$.

The brief coping orientation to problems experienced (Brief-COPE-28)

The Brief-COPE was designed to measure effective and ineffective ways of coping with a stressful life event. It was developed

as a short version of the original 60-item COPE scale (47), which was theoretically derived based on various models of coping. Brief-COPE is a 28 item self-report questionnaire that uses a 4-point Likert-type response scale to evaluate the frequency of various strategies used in stressful situations (1 = I usually do not do this at all, 4 = I usually do this a lot). Higher scores on each subscale indicate higher frequency of strategy use. The abbreviated version of 28 items has been validated in different languages and contexts, demonstrating different factorial structures, ranging from the grouping of 2 factors (adaptive and maladaptive strategies) to the structure proposed by the original English scale of 14 factors: active coping, planning, positive reframing, acceptance, humor, religion, having emotional support, having instrumental support, self-distraction, denial, venting, substance abuse, behavioral disengagement, and self-blame (47). For the present study we used the abbreviated version translated into Spanish by Morán et al. (48). In the Morán et al. study, an overall Cronbach’s alpha of 0.86 was obtained, and its factors ranged from 0.30 (acceptance) to 0.93 (substance use).

Given that one can find different factor structures and psychometric properties in the Brief COPE-28 scale depending on the selected population (49), coupled with the lack of information regarding the adolescent population, the factor structure of the Spanish version was analyzed with the Chilean adolescent sample before performing the analyses at the heart of this study. For this purpose, the data was divided into two random samples; one for exploratory factor analysis (EFA) ($n = 660$) and the other for confirmatory factor analysis (CFA) ($n = 660$). The EFA was estimated by the weighted generalized least squares (GLS) factorization method and oblimin rotation to account for non-normal distribution of items. This suggested a solution of 7-factors, including 26 items (2 items inverted). Absolute values of standardized factor loadings were between 0.35 and 0.93 (factor loadings range for each factor are presented in [Supplementary Table S1](#)).

The factors were: (a) socio-emotional support, considering emotional and instrumental support (4 items, i.e., “I’ve been getting emotional support from others”), (b) active coping, including thinking about how to cope with the stressor, planning, performing actions to eliminate or reduce the stressor, and negative behavioral disengagement items were included as reversed items (6 items, i.e., “I’ve been thinking hard about what steps to take”), (c) maladaptive strategies, includes self-blame, venting and denial strategies (5 items, i.e., “I’ve been criticizing myself”), (d) substance use, drinking alcohol or using other substances in order to feel good or to cope with the stressor (2 items, i.e., “I’ve been using alcohol or other drugs to help me get through it”), (e) humor (2 items, i.e., “I’ve been making jokes about it”), (f) religion or spiritual beliefs (2 items, i.e., “I’ve been praying or meditating”), (g) acceptance and perspective change, including items of acceptance, positive reframing, and self-distraction (5 items, i.e., “I’ve been trying to find the good in what is happening”).

This structure was confirmed in CFA with acceptable model fit values [$\chi^2(277) = 707.619$, $p < 0.001$, CFI = 0.91, TLI = 0.90, SRMR = 0.05, RMSEA = 0.05 (90% CI, 0.046–0.055)]. This was estimated by the weighted least squares method adjusted for mean and variance (WLSMV) to account for non-normal distribution of items. Good fit was indicated by a nonsignificant chi-square, RMSEA and SRMR values less than 0.05. CFI and TLI greater than or equal to 0.95 are indicators of good fit and between 0.90 and 0.95 as acceptable values (for more information on the factor analyses, see [Supplementary material](#)).

TABLE 1 Descriptive statistics and correlation for study variables.

Variable	<i>n</i>	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9	10	11
1. Sex	1,320	0.57	0.50	–										
2. Age	1,320	16.03	1.27	–0.01	–									
3. Life Satisfaction	1,320	6.75	2.12	–0.28***	0.01	–								
4. Internet addiction	1,263	2.43	0.85	0.34***	0.05	–0.28***	–							
5. Active coping strategies	1,300	2.92	0.53	–0.16***	0.09***	0.39***	–0.18***	–						
6. Maladaptive strategies	1,300	2.06	0.57	0.23***	–0.02	–0.42***	0.37***	–0.25***	–					
7. Substance use strategies	1,300	1.15	0.46	0.06*	0.10***	–0.18***	0.14***	–0.15***	0.18***	–				
8. Humor strategies	1,298	2.46	0.97	0.05	–0.01	–0.08**	0.13***	–0.01	0.21***	0.10***	–			
9. Religion strategies	1,287	1.58	0.77	0.06*	0.02	0.10***	0.09***	0.18***	0.04	–0.05	–0.05	–		
10. Acceptance and change of perspective strategies	1,300	2.60	0.55	0.00	0.03	0.17***	0.05	0.29***	0.05	–0.05	0.22***	0.21***	–	
11. Socio-emotional support strategies	1,300	2.30	0.71	–0.16	0.03	0.27***	0.04	0.25***	0.03	–0.06*	0.05	0.19***	0.26***	–

Pairwise deletion was applied to correlations.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

The overall reliability of the present study, as assessed by Cronbach's alpha, was $\alpha = 0.77$, and the alphas of the scales ranged from $\alpha = 0.60$ (acceptance and change of perspective scale) to $\alpha = 0.91$ (substance abuse scale).

Demographic variables

The age (continuous variable) and gender (dichotomous variable; 0 = Male and 1 = Female) variables were used as self-reported control variables.

Data analysis

Initially, an exploratory factor analysis and a confirmatory factor analysis were performed to determine the factor structure of the Brief-Cope 28 scale in the Chilean adolescent population. The RStudio program version 4.1.3 was used for this purpose.

A descriptive and correlational analysis of the variables was carried out. For this, and the following analyses, the total mean score of the student life satisfaction scale (SLSS), the total mean score of the BSMAS scale and mean scores of the 7 factors of the COPE scale were used. In addition, demographic variables (age and gender) as control variables were used.

To account for the study objective, a multiple linear regression analysis was performed to examine the additive and multiplicative effects of social media addiction risk (BSMAS scale) and coping strategies (COPE scale) on students' life satisfaction (SLSS scale). The hierarchical linear regression analysis was performed by entering the predictor variables of the model in the following order: gender and age (first step), social media addiction risk (second step), adaptive and maladaptive coping strategies (third step), and 4 two-way interaction terms of the most important coping strategies (acceptance and change of perspective, socio-emotional support, active coping and maladaptive strategies) for social media addiction risk were included at the end (fourth step). The quantitative variables of the model were mean-centered. Mean-centered variables were used to fit the interaction terms (50).

Two procedures were used to interpret significant interaction terms. The first was the simple slopes method (50, 51) in which a few values of the moderator are chosen to be fixed (usually mean value,

one SD plus the mean and one SD less the mean), and the significance of the focal predictor of the criterion variable is estimated. The main drawbacks of this method are that any value for the moderator can be considered arbitrary (52). To overcome this weakness, the Johnson and Neyman (JN) technique (52) was used. This technique solves for the moderator values for which the effect of the predictor on the criterion variable becomes or ceases to be significant by estimating the lower and upper bounds of the confidence bands, estimating the effect of a predictor on the criterion variable. Also, a graph of the confidence bands makes it easy to show for which values of the moderator the effect of the focal predictor on the criterion variable is significant (52).

Descriptive and multiple regression analyses were performed with the SPSS version 26. Also, the PROCESS macro version 3.5 for SPSS (51) was used to estimate simple slopes and for the JN technique. Since the PROCESS macro does not have the option of including 4 two-way interactions, the simple interaction model was used instead (model 1), with acceptance and perspective change as the moderator in the relationship of the focal predictor relationship (risk for social media addiction) on students' life satisfaction, controlling for the other variables included in the model (sex, age, other coping strategies and the remaining 3 two-way interactions). The graphs were created in Excel.

Results

Descriptive

Bivariate correlations, means, and standard deviations for demographic variables, social media addiction risk, coping strategies and students' life satisfaction are presented in Table 1. The social media addiction risk was negatively associated with students' life satisfaction ($r = -0.28$, $p < 0.001$). With respect to coping strategies, most adaptive ones were positively related to general life satisfaction ($r = 0.09$ – 0.39) and maladaptive strategies were inversely correlated with it ($r = -0.18$ to -0.42). Only the use of humor did not follow the aforementioned pattern, presenting a negative correlation with life satisfaction ($r = -0.08$, $p < 0.01$). Moreover, only active coping ($r = -0.18$, $p < 0.001$), but not the other adaptive strategies, was negatively correlated to social media addiction risk, and maladaptive ones were directly correlated with it

TABLE 2 Hierarchical regression results for adolescent's life satisfaction.

Variable	<i>B</i>	95% CI for <i>B</i>		<i>SE B</i>	β	<i>R</i> ²	ΔR^2
		LL	UL				
Model 1						0.08	0.08***
Constant	7.44***	7.27	7.64	0.09			
Sex	−1.22***	−1.45	−0.99	0.12	−0.28***		
Age	0.04	−0.05	0.13	0.05	0.02		
Model 2						0.12	0.04***
Constant	7.27***	7.09	7.44	0.09			
Sex	−0.92***	−1.16	−0.68	0.12	−0.21***		
Age	0.06	−0.03	0.15	0.05	0.04		
Internet addiction	−0.51***	−0.65	−0.38	0.07	−0.21***		
Model 3						0.35	0.23***
Constant	7.10***	6.95	7.25	0.08			
Sex	−0.62***	−0.83	−0.42	0.11	−0.15***		
Age	0.00	−0.07	0.07	0.04	0.00		
Internet addiction	−0.21**	−0.34	−0.09	0.07	−0.08**		
Active coping ^a	0.78***	0.57	0.98	0.10	0.19***		
Acceptance and change of perspective ^a	0.32**	0.13	0.52	0.10	0.08**		
Socioemotional support ^a	0.60***	0.45	0.74	0.07	0.20***		
Maladaptive strategies ^a	−1.15***	−1.34	−0.95	0.10	−0.03***		
Substance use ^a	−0.26*	−0.48	−0.04	0.11	−0.05*		
Humor ^a	−0.04	−0.14	0.07	0.05	−0.02		
Religion ^a	0.10	−0.03	0.23	0.07	0.04		
Model 4						0.35	0.01***
Constant	7.08***	6.92	7.24	0.08			
Sex	−0.60***	−0.81	−0.40	0.11	−0.14***		
Age	0.01	−0.07	0.08	0.04	0.00		
Internet Addiction	−0.22**	−0.35	−0.09	0.07	−0.09**		
Active coping ^a	0.77***	0.57	0.97	0.10	0.19***		
Acceptance and change of perspective ^a	0.31**	0.11	0.50	0.10	0.08**		
Socioemotional support ^a	0.62***	0.48	0.76	0.07	0.21***		
Maladaptive strategies ^a	−1.14***	−1.33	−0.95	0.10	−0.3***		
Substance use ^a	−0.25*	−0.47	−0.03	0.11	−0.05*		
Humor ^a	−0.04	−0.15	0.06	0.05	−0.02		
Religion ^a	0.09	−0.04	0.22	0.07	0.03		
Internet addiction * Active coping ^a	0.17	−0.06	0.40	0.11	0.04		
Internet addiction * Acceptance and change of perspective ^a	0.31**	0.10	0.52	0.11	0.07**		
Internet addiction* Socioemotional support ^a	−0.14	−0.31	0.03	0.09	−0.04		
Internet addiction* Maladaptive strategies ^a	0.11	−0.08	0.31	0.10	0.03		

CI, confidence interval; LL, Lower limit; UL, Upper limit. ^aStress-coping strategies.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

($r = 0.14$ – 0.37). In this case, both humor and religion use for coping with stress were associated with a higher social media addiction risk.

Additive effects of social media addiction risk and coping strategies on students' life satisfaction

First, we examined the social media addiction risk and coping strategies as predictors of students' life satisfaction, controlling for

participants' age and gender with a hierarchical linear regression model (steps 1–3, Table 2).

The first step of the hierarchical multiple regression indicated that control variables accounted for 8% of the life satisfaction variance, $F(2,1257) = 55.91$, $p < 0.001$. In this step, coefficients indicated that females had a lower level of life satisfaction than males and that the students' age was unrelated. Furthermore, the second step indicated that while controlling for demographic variables, social media risk was negatively associated with life satisfaction, accounting for the 3.7% of life satisfaction variance, $F(1,1256) = 53.33$, $p < 0.001$. The third step

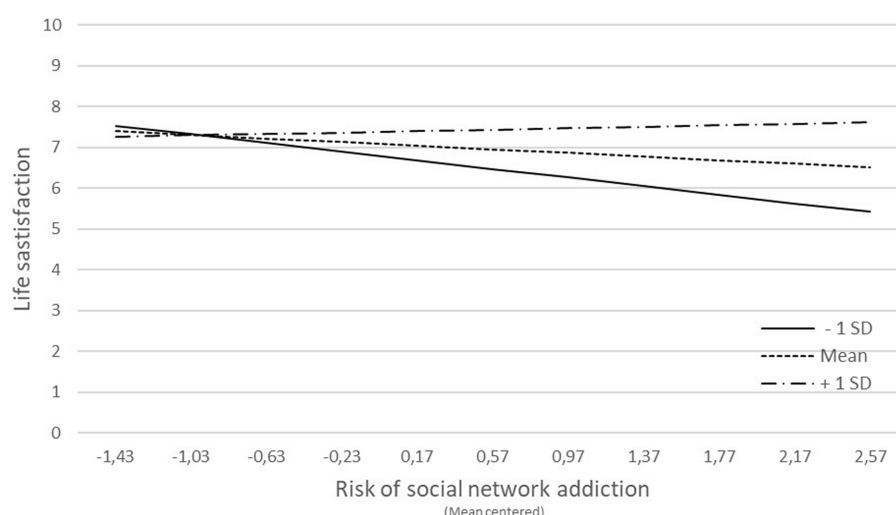


FIGURE 1

Moderating effect of acceptance and perspective change coping strategy on the relationship of risk of social network addiction to student's life satisfaction: Simple slopes at 1 SD below the mean (-1 SD), mean value (Mean) and 1 SD above the mean ($+1$ SD).

indicated that, controlling for students' age and sex, both social media risk ($\beta = -0.09$, $p < 0.001$) and some stress coping strategies were significant predictors of student's life satisfaction. This model accounted for 35% of the life satisfaction variance, $F(10.1249) = 68.10$, $p < 0.001$. Specifically, active coping, acceptance and perspective change and socio-emotional support were positively correlated to student's life satisfaction, with substance use and maladaptive strategies being negatively correlated.

Multiplicative effects of stress coping strategies in the connection between social media addiction risk with students' life satisfaction

To clarify the moderating role of coping strategies in the association of social media risk and students' life satisfaction, in step 4 of the regression model (Table 2) we included a series of two-way interaction terms related to four specific coping strategies (acceptance and perspective change, socio-emotional support, active coping and maladaptive strategies) and social media addiction risk variables.

This last step of the hierarchical multiple regression indicated that interaction terms accounted for less than 1% of the life satisfaction variance, $F(4, 1,245) = 3.59$, $p < 0.01$. In this model, coefficients indicated that the acceptance and perspective change coping strategy is able to modify the negative relationship between social media addiction risk and student's life satisfaction. No other interaction term was statistically significant.

This significant interaction term indicates that the adverse effect of social media addiction risk on adolescent's life satisfaction was less pronounced the more they are able to accept and perspective change in front of a stress situation. For example, when acceptance and perspective change is one SD below the mean, the beta regression coefficient $\beta = -0.39$, ($p < 0.001$) whereas their value is $\beta = -0.22$, ($p < 0.001$) at the mean value of acceptance and perspective change, and the relationship between social media addiction risk with

students' life satisfaction was not significant when acceptance and perspective change is one SD above the mean, $\beta = -0.06$, $p > 0.05$ (see simple slopes, Figure 1).

In fact, the JN technique indicated that when the mean-centered level of acceptance and change perspective is higher than 0.262 (corresponding to 2.70 points on the original scale), there is no correlation between social media addiction risk with students' life satisfaction (the confidence interval contains the value zero). Below this value it indicates that the adverse effect of social media addiction risk on adolescent's life satisfaction is less pronounced-or these simple slopes are less negative-as they are more able to accept and change perspective when dealing with a stressful situation (see Figure 2).

Discussion

Our results support our hypothesis that social media addiction risk negatively correlates to life satisfaction. Also, adaptive strategies such as seeking socio-emotional support, active coping and acceptance, and being able to change perspective were positively correlated to adolescents' life satisfaction. Moreover, maladaptive strategies and substance use were negatively correlated with life satisfaction. The interaction effect between these variables on life satisfaction was observed only for the acceptance and perspective-taking strategy, albeit with a small effect size.

The results regarding a negative association between the risk of internet and social network addiction with student life satisfaction is similar to that reported in other studies conducted both before and after the pandemic, negatively impacting all areas of life satisfaction (53). For example, one study that sought to comprehend the relationship between internet addiction and areas of life satisfaction found that these variables were negatively correlated in a highly significant way (31). Similarly, another study aimed to work out the effects of uncertainty during the pandemic in a group of adolescents. A negative and highly significant connection between internet addiction and satisfaction

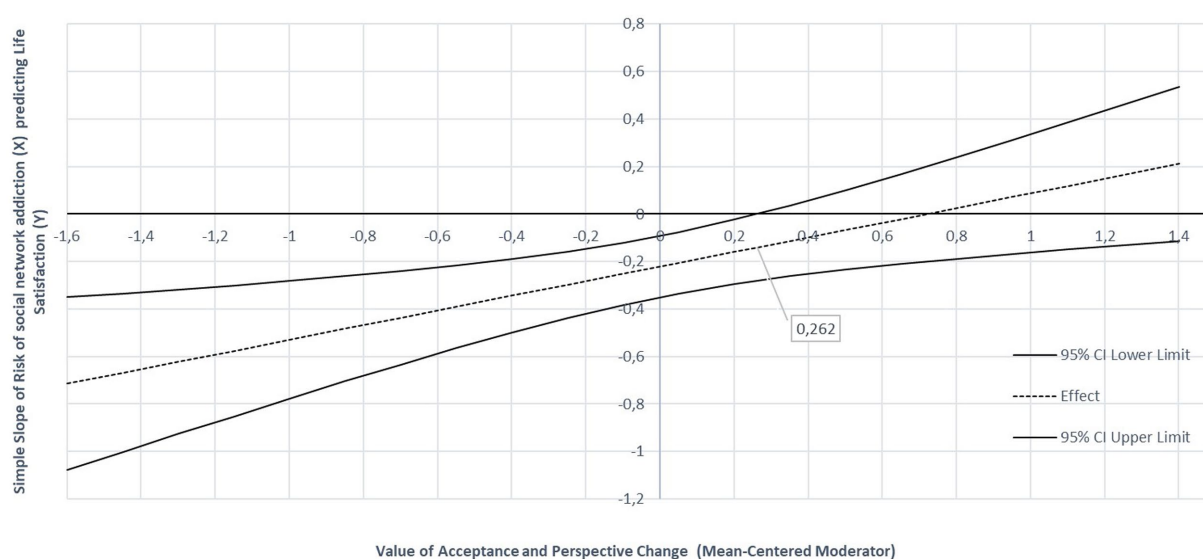


FIGURE 2

Johnson Neyman graph of the conditional effect of risk of social network addiction on student's life satisfaction. The Y axis represents the simple slopes effect. The X axis represents the moderator values (Acceptance and Perspective Change coping strategy). Created on bases Johnson Neyman PROCESS macro data.

with students' lives was observed (53–55). In turn, as reported by Yu and Shek (15) in their longitudinal study, internet addiction would explain worse outcomes in adolescents' life satisfaction, which is in keeping with what is reported in the present work, as internet addiction would explain 3.7% of the variance in life satisfaction.

Our second result is consistent with previous research indicating that cognitive and problem-focused coping strategies have been found to mitigate the negative impact of pandemic-related stressors on Western adolescents' life satisfaction (42) and serve as protective factors against emotional maladjustment for Eastern adolescents (56).

The COVID-19 pandemic can be characterized as a period of high unpredictability and uncertainty that adolescents are experiencing for the first time in their lives (7, 42, 57). Furthermore, it involves a series of unanticipated/manageable events; for example, the possibility of getting sick with COVID-19, the imposition of staying locked inside during quarantines, among others (58). In these cases, the use of adaptive coping strategies to face these stressful events is very relevant in order to maintain better levels of life satisfaction.

It is also relevant to note that coping strategies used by adolescents might be influenced by their parents' actions and/or family dynamics (59–61). For example, based on bidirectional effects between adults and their children, Shi and Wang (62) reported that adolescents who perceived more supportive parental reactions to their negative emotions before the COVID-19 pandemic used more approach-coping and less avoidance-coping when managing pandemic-related stress, which was associated with lower emotional maladjustment for adolescents during the pandemic. In contrast, those who perceived more unsupportive parental reactions before the pandemic used more avoidance-coping, which was associated with higher emotional maladjustment symptoms. Thus, the coping strategies used by adolescents potentially capture the intrafamilial relational dynamics in which they were immersed during the pandemic that had impacts on adolescents' life satisfaction (58).

Maladaptive coping strategies may also indirectly impact adolescents' general life satisfaction. For example, van Loon et al. (63) reported that adolescents with maladaptive coping strategies including self-blame, other-blame, rumination, and catastrophizing before the pandemic experienced higher levels of COVID-19-related concerns about either getting sick themselves or relatives falling ill. The authors conclude that adolescents who use more maladaptive coping strategies in the face of stressful situations may view the risk of becoming seriously ill to be the most unpredictable and uncontrollable. This fear and/or worry has a significant effect in reducing their satisfaction with life (64).

We evaluated a moderation model in which four stressful management strategies, namely, acceptance and perspective-taking, seeking socio-emotional support, active coping, and maladaptive strategies, conditioned the relationship between social media addiction risk and life satisfaction (controlled by demographic variables and the specific strategies of using humor, religion, and substances). It is striking that only the ability to accept and take perspective on situations could buffer the relationship between social network use and life satisfaction.

The COVID-19 pandemic and associated restriction measures were beyond the control of individuals, particularly children and adolescents (58). Acceptance means facing reality even if it does not fit one's expectations or desires and the willingness to deal with the situation nevertheless. Acceptance can help one adapt to unchangeable adverse events by helping maintain the individual's psychological wellbeing and capacity to act. Thus, acceptance is characterized as giving up the striving for situation control, withdrawing the individual's energy from a situation where further attempts would be fruitless, and redirecting the energy into other more constructive actions (65). In this sense, the ability to accept COVID-19 may be a coping strategy that—unlike the others considered in the study—would have a direct effect on the general wellbeing of adolescents.

Moreover, finding a positive aspect of the COVID-19 pandemic (positive reframing) and being able to self-distract are two useful coping strategies, that have the potential to positively influence satisfaction with life. For example, given that adolescents were indoors most of the time, they could have developed domestic or other supportive activities that let them distract or entertain themselves (66, 67). Our interaction effect indicated that the level of life satisfaction was not correlated to the abusive use of social networks for those adolescents who were highly capable of accepting the COVID-19 situation and its restrictions on daily life, found something positive about it (positive reframing) and were able to self-distract. In contrast, adolescents who reported having low or average levels of acceptance and perspective-taking presented a negative correlation between abusive use of social networks and general satisfaction with life, as this relationship was more marked as lower levels of acceptance and perspective-taking of adolescents.

We found that adolescents with lower levels of acceptance were at greater risk of social network addiction the lower their satisfaction with life, which is consistent with other studies that have shown that social network abuse is associated with higher levels of anxiety and depression, increased isolation, decreased physical activity, low self-esteem, poor sleep quality, and more (68). In contrast, when they had higher acceptance levels with positive reframing, social network addiction risk did not influence life satisfaction. In this sense, using this strategy turned them into resilient people. There is consensus that two crucial aspects must be present to qualify as resilient; an experience of adversity and a subsequent positive adaptation (69, 70). Such an adolescent can positively overcome their risky use of social media.

Studies that include mental health problems have reported on this buffer role of psychological flexibility (71, 72). For example, Liu et al. (73) discussed the moderating role of psychological inflexibility in the association between distress-driven impulsivity and problematic internet use. They conclude that people who engage in instantly gratifying behaviors such as internet use/abuse when facing stressful events or negative emotions find short-term relief for their negative mood, thereby possibly incorporating this as a coping strategy through negative reinforcement. Over time, such coping strategies may bring aversive consequences; for example, too much time spent online at the expense of time spent on schooling or increased isolation. At this point, flexible individuals may be able to change their behavior and avoid negative consequences. However, inflexible individuals may be unable to do so and would be more likely to continue using the internet as a coping strategy, despite the consequences (74). So, in the case of our interaction results, when adolescents reported higher levels of acceptance and positive reframing, which reflects higher psychological flexibility, life satisfaction was not influenced by social media addiction risk because they were able to change their risky addiction behavior as they experienced the aversive consequences associated with it. This individual mechanism is an example of resilience theory (75) which highlights the importance of individual resources as protective factors to manage risk, and adverse experiences, such as the Pandemic.

Despite our results, the study has its limitations. The first one is its cross-sectional design, which does not allow inferences about causality between the occurrence of social media addiction risk or coping strategies and adolescents' life satisfaction. A second limitation is the use of self-reported data without any other sources of information.

However, this was the best way to collect data from adolescents during the pandemic period. A third limitation is a factorial solution for the Brief Coping Orientation to Problems Experienced scale. As we reported in the study, there was not only one factorial solution for this measure, which can limit the comparison with other studies using the same instrument. Nevertheless, we reported the factorial structure of the study sample. Lastly, even though we controlled for age and sex in our analysis, we did not include additional sample characteristics that would enable an examination of subgroups, such as sexual diversity, immigrant students, or those belonging to different ethnic groups.

At a theoretical level, the implications of this research are that it provides new knowledge regarding the relationship between coping mechanisms and satisfaction with adolescent life. It also provides important information regarding the effects of Internet addiction on adolescent life and mental health. These findings are relevant in that they allow us to continue to delve deeper, not only in a pandemic or post pandemic context regarding the implications for adolescent wellbeing and mental health, but also as a situation that is always relevant and current for the infant and adolescent population. On the other hand, the practical implications of this research are related to the fact that it provides information that can be useful for public policy makers, school administrators and people who work directly with children and adolescents in that it provides relevant information regarding which coping mechanisms would be most important to strengthen when generating interventions that could help to address mental health problems associated with Internet addiction that adolescents suffer so frequently today. Also, the present work provides relevant information that helps to put the focus and importance of working on promoting mental health and satisfaction with adolescent life especially in this post pandemic time that has greatly and strongly affected this age group.

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 Universidad del Desarrollo Ethics Committee. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

Author contributions

JV and MR-R: conceptualization. JV, JP, MR-R, and JR: methodology. JP, JR, and MR-R: formal analysis. MR-R and MC: data curation. All authors contributed to the manuscript writing of sections of the manuscript, read, and approved the submitted version.

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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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Supplementary material

The Supplementary material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fpsy.2023.1211431/full#supplementary-material>

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