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The relationship between childhood trauma and internet addiction in adolescents: A meta-analysis

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REVIEW ARTICLE



ABSTRACT

Objective: Many studies have explored the relationship between childhood trauma and internet addiction from different theoretical perspectives; however, the results have been inconsistent. The purpose of this meta-analysis was to examine the relationship between childhood trauma and internet addiction. **Methods:** The PubMed, Web of Science, Embase, CNKI, Wanfang and VIP electronic databases were searched to identify studies examining the correlation between childhood trauma and adolescent internet addiction. The databases were searched from inception to December 31, 2022. Two researchers independently screened the literature, extracted the data, and evaluated the risk of bias of the included studies. Then, Stata 17.0 software was used to perform meta-analysis. **Results:** This study was registered on PROSPERO (CRD42023388699). A total of 19 studies involving 21,398 adolescents were included in this meta-analysis. The random effects model was used for pooled analysis, and the results revealed a strong positive association between childhood trauma and internet addiction ($r = 0.395$, 95% CI [0.345, 0.442]). The relationship between childhood trauma and internet addiction was moderated by sample size, survey area, and internet addiction measurement tools. There were significant differences between the associations based on the various child trauma measurement tools and study quality scores. However, interstudy heterogeneity was not significantly affected by study year, sample source, or participant age. **Conclusion:** Internet addiction is positively correlated with childhood trauma. Therefore, it is extremely important for parents to provide a good growth environment during childhood to enhance the physical and mental development of adolescents. A warm family atmosphere helps individuals develop a healthy personality, thereby reducing or preventing the occurrence of internet addiction. Due to the limited number and low quality of the included studies, the above conclusions need to be verified by additional high-quality studies.

KEYWORDS

childhood trauma, internet addiction, adolescents, meta-analysis

INTRODUCTION

Due to the rapid development of smart electronic devices and the internet, internet access has become an indispensable part of people's lives in recent years (Al-Khani et al., 2021). Research has shown that the population of internet users is becoming increasingly younger. The current internet use rate among adolescents is 94.9% (Internet Network Information Center, 2022). A previous meta-analysis found that an estimated 6% of adolescents suffer from internet addiction (Cheng & Li, 2014).

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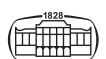
There is no universal definition of internet addiction. And internet addiction currently is not recognized as a formal diagnosis in modern psychiatric nosology. In addition, whether a person is addicted to the internet or to specific content on the internet (e.g., games, social media, gambling, pornography) is also widely debated. Internet addiction is often characterized by excessive use of the internet or inability to concentrate and control the desire to use the internet, resulting in functional impairment or pain (Weinstein et al., 2014). The concept of internet addiction was first proposed by Goldberg, who suggested that internet addiction is a behavioral addiction disorder (Goldberg, 1994). Young then referred to the diagnostic criteria provided in the DSM-IV and pathological gambling, where internet addiction is defined as an individual's uncontrollable urge to go online without the influence of an addictive substance. Young divided internet addiction into five subtypes: online game addiction, internet communication addiction, internet information collection addiction, internet technology addiction (compulsive online gambling, shopping or trading) and internet pornography addiction (Young, 1996). Some scholars also define individuals with internet addiction as "users who repeatedly use the Internet for a certain amount of time, their cognitive functions, emotional functions and behavioral activities, even physiological activities, deviate from real life and suffer serious harm, but still cannot reduce or stop using the Internet" (Brand et al., 2016). The World Health Organization (WHO) defines internet addiction as a chronic or periodic state of addiction caused by excessive use of the internet and an irresistible desire to use it again. Moreover, individuals with internet addiction want to increase their internet use time, show an increased tolerance, and experience withdrawal reactions; these individuals will exhibit psychological and physiological dependence on the pleasure derived from the internet. Based on the physical and mental development characteristics of adolescents and the classic definition of internet addiction used by most researchers, this study defines internet addiction as an spending too much time on internet activities (such as using social networking sites, online games and online chatting), resulting in behavioral and psychological disorders in daily life (Zhang et al., 2022).

Internet addiction may affect the structural transformation and maturation of the brain in children and adolescents (Chen et al., 2020; Chung, Lee, & Lee, 2019; Leung, 2014). This disrupts the development of certain areas of adolescent psychology, such as reward anticipation, decision-making, emotional processing, and impulse control (Hurd et al., 2014; Jimeno et al., 2022). These disruptions can also lead to more serious psychological and behavioral problems in adolescents (Eppright et al., 1999; Luengo Kanacri et al., 2014; Truong et al., 2017). Among adolescents who do not receive adequate parental supervision, internet addiction may lead to problems such as anxiety, depression, irritability, poor behavioral control, decreased attention, poor executive function, personality changes, and negative self-perception (Huang et al., 2020; Ma, Huang, & Ma, 2020a, b; Wei et al., 2021). Internet addiction can also

disrupt adolescents' sleep patterns by damaging their brain structure and function (Gentile et al., 2017; Ma, Huang, & Ma, 2020a, b; Wei et al., 2021). This can result in academic disabilities, interpersonal disengagement, and further deterioration of interpersonal relationships/impairment of many social functions (Caballo, 1995; Gür et al., 2015; Kuss, & Lopez-Fernandez, 2016).

According to previous studies, potential risk factors for internet addiction include masculinity, depressive symptoms, high neuroticism, poor parent-child relationships, etc., (Lam, 2014; Nakayama, Mihara, & Higuchi, 2017). Among the risk factors for internet addiction, the presence and intervention of parental and family factors have received increasing attention in recent years, among which childhood trauma is one of the most common factors (Bussone et al., 2020; Lo et al., 2021). Childhood trauma, which includes sexual abuse, physical and emotional abuse, and physical and emotional neglect, is currently a major public health problem worldwide, especially in developing countries (Aydin, Altindag, & Ozkan, 2009; Bernstein et al., 2003). Childhood trauma increases the risk of internalizing and externalizing problems in children and adolescents, as it alters their brain development and leads to a variety of short- and long-term negative effects (Elliott et al., 2014; Teicher et al., 2016). Previous findings have shown that childhood trauma increases the risk of behaviours such as substance abuse and internet addiction (Skinner et al., 2016; Worsley et al., 2018). Specifically, this is mainly because adolescents who have experienced trauma during childhood may develop insecure attachments that lead to negative emotional and behavioral consequences (Forster et al., 2021). Teenagers who grow up in insecure home environments and experience childhood trauma may alleviate negative emotions through excessive use of the internet, eventually leading to internet addiction. From a neurophysiology perspective, family stressors (e.g., childhood trauma) can disrupt the stress response system of adolescents, alter neural structure and functioning, and increase susceptibility to internet addiction (Danese & McEwen, 2012; Forster et al., 2021).

In recent years, many studies have investigated the relationship between childhood trauma and internet addiction and found that there is a positive correlation between childhood trauma and internet addiction. The more severe childhood trauma is, the greater the risk of internet addiction. However, the R values of the association between childhood trauma and internet addiction may vary due to differences in study methods. For example, in the studies by Manji Hu et al. and Jhone, J. H. et al., the R values of the relationship between childhood trauma and internet addiction were 0.149 and 0.166, respectively (Hu et al., 2021; Jhone et al., 2021). However, in the studies conducted by Xiahua Hou et al. and Jingxuan Li et al., the R values of the relationship between childhood trauma and internet addiction were 0.41 and 0.442, respectively (Hou et al., 2021; Li, 2022). Confirming the relationship between internet addiction and childhood trauma could facilitate the development of effective strategies for early intervention and treatment



approaches for internet addiction among adolescents. Therefore, we conducted a meta-analysis to obtain strong evidence regarding the relationship between childhood trauma and internet addiction.

METHODS

Literature search strategy

This meta-analysis was conducted in accordance with the Preferred Reporting Items of the Guidelines for Systematic Evaluation and Meta-Analysis (PRISMA) 2020 (Page et al., 2021). In addition, the protocol was registered with PROSPERO (CRD42023388699), a forward-looking international systematic review registry. In January 2023, we searched the CNKI, VIP, Wanfang, Web of Science, Embase and PubMed databases to identify studies on the relationship between internet addiction and childhood trauma. Detailed search formulas used by each database are shown in Table 1. The study selection process is shown in Fig. 1. The databases were searched from inception to December 31, 2022. Documents such as meetings, congresses, meetings, reports, memoranda or letters were not included. In addition, Google Scholar and CNKI were searched to identify grey literature that met the inclusion criteria. Other relevant studies were identified by manually searching the reference lists of the retrieved articles. In addition, other relevant studies were retrieved from the lists of references in the search article. After removing duplicate studies, 1,180 articles were subjected to screening.

Inclusion criteria

The retrieved articles were first initially screened by reviewing the titles and abstracts and then further screened by reading the full texts to identify the studies that met the criteria. Articles were screened based on the inclusion and exclusion criteria (Azer & Azer, 2015). The inclusion criteria were as follows: (1) empirical articles on the relationship between childhood trauma and internet addiction were included; reviews and qualitative studies were not included; (2) there were clear definitions of childhood trauma and internet addiction in the study; (3) the study population was mainly 10–24-year-old individuals; (4) the study included specific data on the association between childhood trauma and internet addiction (e.g., correlation coefficients and sample sizes) or other indicators that can be translated into effect sizes without significant error; (5) the study assessed childhood traumatic life experiences using the Childhood Trauma Short Form Questionnaire (CTQ-SF), Adverse Childhood Experiences Measurement Tool (ACES), or Traumatic Experiences Checklist (TEC); adolescent internet addiction status was assessed using the IAT, GUESS, MPAI, MPA, MPATS, APIUS, IADD, Smartphone App Addiction Scale, or the Adolescent Problematic Mobile Social Media Use Assessment Questionnaire; (6) papers were published English and Chinese; and (7) non-duplicate datasets. If multiple studies used the same dataset, the study with the largest sample size was included. If

multiple studies using the same dataset were published in academic journals, the study with the largest sample size was included. If multiple studies using the same dataset were published in academic journals, the published journal papers were retained. The exclusion criteria were as follows: (1) incomplete text and (2) no information on the outcomes of interest. A total of 19 eligible articles/studies were ultimately included in this meta-analysis based on the above inclusion and exclusion criteria. We further reviewed the relevant data included in this study and did not find any missing data. Therefore, we did not contact the original authors to obtain the relevant original data.

Data extraction and quality assessment

Two evaluators independently selected the literature, extracted the data and cross-checked the data. In cases of disagreement, a third party was consulted to assist in the judgement. If there was a lack of data, the author was contacted. The following data were extracted: year of publication, survey region, sample size, sample source, and measurement tools used to assess childhood trauma and internet addiction (see Table 2). Disagreements regarding data extraction were resolved via discussion. Ten percent of the included and excluded studies were subjected to data extraction by third parties to ensure accuracy. The p_0 value of this study was 0.91, and the p_e value was 0.56. The kappa value of this study (0.77) was calculated as follows: $\text{Kappa} = (p_0 - p_e) / (1 - p_e)$ (Cantor, 1996).

If the correlation coefficient r was not reported in the included studies but F , t and χ values were reported, these parameters were converted to r values using the following corresponding formula: $r = \sqrt{\frac{t^2}{t^2 + df}}$, $r = \sqrt{\frac{F}{F + df}}$ and $r = \sqrt{\frac{\chi^2}{\chi^2 + N}}$ (Cumming, 2012). Second, effect sizes were extracted using independent coding, coded once for each independent sample. If several different samples were investigated in the same study, then these samples were recorded in the table using separate coding forms.

Risk assessment of bias in the included studies

Methodological quality was evaluated independently by two researchers back-to-back, and disagreements were resolved by group discussion. We evaluated the quality of the included studies using the Agency for Health Care Research and Quality (AHRQ) tool (Rostom et al., 2004). The AHRQ tool includes 11 questions, and the maximum score is 11. Low-quality research was indicated by an overall score of less than 3, medium-quality research was indicated by an overall score of 4–7, and high-quality research was indicated by an overall score of 8–11. Appendix A presents a detailed scale and results for assessing the risk of bias in included studies.

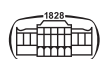
Effect size calculation

Effect sizes were extracted using a meta-analysis of Pearson product moment coefficients (r). Specifically, the coefficient r was mainly Fisher transformed using Fisher's $Z = 0.5 \times \ln$



Table 1. Literature search results of each database

Database	Search mode	Number of selected documents
PubMed	(adverse childhood experiences OR Adverse Childhood Experience OR Childhood Experience, Adverse OR Childhood Trauma, Adverse OR Childhood Trauma OR Childhood Traumas OR Trauma, Childhood OR Traumas, Childhood OR Traumatic Childhood Experiences OR Childhood Experience, Traumatic OR Childhood Experiences, Traumatic OR Experience, Traumatic Childhood OR Experiences, Traumatic Childhood OR Traumatic Childhood Experience OR Adolescent Trauma OR Adolescent Traumas OR Trauma, Adolescent OR Traumas, Adolescent OR Early Life Stress OR Early Life Stresses OR Life Stresses, Early OR Stresses, Early Life OR Early-Life Stress OR Early-Life Stresses OR Stress, Early-Life OR Stresses, Early-Life) AND (internet addiction disorder OR Internet addiction OR Addiction Disorder OR Addiction Disorder, Internet OR Addiction Disorders, Internet OR Disorder, Internet Addiction OR Disorders, Internet Addiction OR Internet Addictions Disorders OR Addiction, Internet OR Addictions, Internet OR Internet Addictions OR Social Media Addiction OR Addiction, Social Media OR Addictions, Social Media OR Media Addiction, Social OR Media Addictions, Social OR Social Media Addictions OR Social Media Addictions OR Smartphone Addiction OR Addiction, Smartphone OR Addictions, Smartphone OR Smartphone Addictions OR Internet Gaming Disorder OR Disorder, Internet Gaming OR Disorders, Internet Gaming OR Gaming Disorder, Internet OR Gaming Disorders, Internet OR Internet Gaming Disorders) AND (adolescent OR Adolescents OR Adolescence OR Teens OR Teen OR Teenagers OR Teenager OR Youth OR Youths)	615
Web of Science	((TS = (Internet addiction or problematic Internet use or Internet addiction disorder or pathological Internet use or Internet game addiction or excessive Internet use or compulsive Internet use or Internet dependency or computer addiction)) AND TS = (adverse childhood experience or childhood abuse or childhood maltreatment or childhood trauma or childhood poly-victimization or childhood sexual abuse or childhood physical abuse or childhood psychological abuse or childhood emotional abuse) AND TS = (adolescent or Adolescents or Adolescence or Teens or Teen or Teenagers or Teenager or Youth or Youths))	354
Embase	((TS = (Internet addiction or problematic Internet use or Internet addiction disorder or pathological Internet use or Internet game addiction or excessive Internet use or compulsive Internet use or Internet dependency or computer addiction)) AND TS = (adverse childhood experience or childhood abuse or childhood maltreatment or childhood trauma or childhood poly-victimization or childhood sexual abuse or childhood physical abuse or childhood psychological abuse or childhood emotional abuse) AND TS = (adolescent or Adolescents or Adolescence or Teens or Teen or Teenagers or Teenager or Youth or Youths))	161
CNKI (China National Knowledge Infrastructure)	(Internet addiction or addiction or Internet abuse or Internet dependence) and (childhood trauma or childhood abuse or adverse childhood experiences) and (adolescents)	130
Wanfang database	(Internet addiction or addiction or Internet abuse or Internet dependence) and (childhood trauma or adverse childhood experiences) and (adolescents)	9
Vip database	(Internet addiction or addiction or Internet abuse or Internet dependence) and (childhood trauma or adverse childhood experiences) and (adolescents)	3



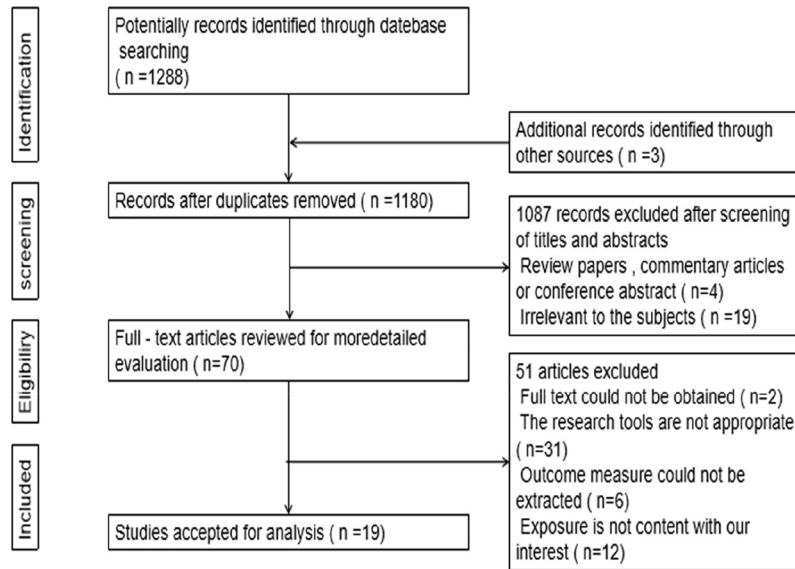


Fig. 1. PRISMA 2009 flow diagram

$[(1 + r)/(1 - r)]$. Using the sample size, the standard error (SE) was calculated as $\sqrt{1/(n - 3)}$. To comprehensively evaluate the correlation between childhood trauma and internet addiction, it is also necessary to convert summary r values to summary Z values by the formula $r = (e^{2Z} - 1)/(e^{2Z} + 1)$ and Z values by Formula $Z = \text{summary Fisher's } Z$.

Statistical analysis

All the data were analysed using Stata, version 17.0. Given that the studies were not considered to reflect the same population, a random effects model was used for the analyses (Borenstein et al., 2010; Dettori, Norvell, & Chapman, 2022; Riley, Higgins, & Deeks, 2011). A homogeneity test was performed to determine whether each result was significantly different from the overall effect size. The statistical heterogeneity between studies was assessed using Cochran's Q test and quantified using the I^2 statistic (Higgins & Thompson, 2002). If the Q test results were significant and $I^2 \geq 75\%$, there was significant heterogeneity (Higgins et al., 2003). High heterogeneity indicates potential moderating effects, and the random effects model was used to conduct moderating and meta-regression analyses to examine potential causes of heterogeneity (Chung, Burns, & Kim, 2006). Funnel plots and Egger's and Begg's tests were used to test for publication bias. In addition, sensitivity analysis was performed using the leave-one-out method to evaluate the impact of each study.

RESULTS

Data synthesis

Figure 2 shows the results of the meta-analysis examining the relationship between childhood trauma and adolescent

internet addiction across the 19 included studies. Using the random effects model, we found that the pooled correlation coefficient was 0.30 (95% CI [0.25–0.35]). However, there was significant heterogeneity in the relationship between childhood trauma and internet addiction ($Q = 322.86$, $I^2 = 92.30\%$, $p < 0.001$).

Subgroup analysis

To further explore the potential reasons for heterogeneity between studies, we conducted subgroup analyses based on study year, sample source, sample size, region, measurement scales, and quality scores. As shown in Table 3, sample size (test for subgroup differences [TSD]: $p = 0.008$), region (TSD: $p = 0.006$), and measurement scales (TSD: $p = 0.007$) moderated the relationship between childhood trauma and internet addiction. There were significant differences based on childhood trauma measurement tools (TSD: $p = 0.000$) and study quality scores (TSD: $p = 0.002$). However, inter study heterogeneity was not significantly affected by study year (TSD: $p = 0.43$), sample source (TSD: $p = 0.184$), or age (TSD: $p = 0.285$).

These results indicated that the relationship between internet addiction and childhood trauma was moderated by the Internet Addiction Measurement Instrument. Childhood trauma had the strongest positive association with internet addiction when the Mobile Social Media Use Assessment Questionnaire for Adolescent Problems was used to assess internet addiction; conversely, childhood trauma had the weakest positive association with internet addiction when the IGUESS scale was used to assess internet addiction. Furthermore, the relationship between childhood trauma and internet addiction was moderated by the Childhood Trauma Test. There was also a significant positive association between childhood trauma and internet addiction when the CTF-SQ was used as a measurement tool.



Table 2. Characteristics of 19 studies included in the meta-analysis

First author	Geographic region	Research design	Ages	Female%	Samples	Samples source	Measurement			JBI score
							r	IA	Childhood trauma	
Hu et al. (2021)	China	self-report	N/A	49.89%	439	Four public high schools	0.149	IAT	CTQ-SF	6
Seo et al. (2020)	Korea	self-report	12.72 ± 1.76	47.22%	180	Elementary school and middle schools	0.27	IGUESS	ACEs	5
Dong et al. (2021)	China	self-report	18.1 ± 2.4	49.20%	1,501	N/A	0.35	IAT	CTQ-SF	7
Yang et al. (2022)	China	self-report	12.96 ± 1.5	49.1%	866	Students from six schools	0.36	IAT	CTQ-SF	7
Jhone et al. (2021)	Korea	self-report	13.75 ± 2.22	56.4%	3,593	Elementary, middle and high schools	0.166	I-GUESS	ACEs	6
Sheng et al. (2022)	China	self-report	12.96 ± 1.49	49.3%	824	7 schools	0.25	IAT	CTQ-SF	7
Ma, Huang and Ma (2020a, b)	China	self-report	13.68 ± 0.92	48.52%	981	Two public junior high schools	0.38	MPAI	CTQ-SF	7
Shi et al. (2020)	China	self-report	N/A	51.5%	922	College students	0.33	IGD	CTQ-SF	5
Hou, Wang, Wang and Zheng (2021)	China	self-report	N/A	58.24%	2,572	College students from two universities	0.41	APIUS	CTQ-SF	8
Dalbudak et al. (2014)	Turkey	self-report	N/A	59.41%	271	The Turgut Ozal University	0.28	IAS	CTQ-SF	5
Schimmenti et al. (2017)	Italy	self-report	18.36 ± 0.38	56.98%	358	Six public high schools	0.20	IAS	TEC	5
Zhang (2023)	China	self-report	14.85 ± 1.487	52.21%	1766	Two middle schools and one high school	0.342	IAS	CTQ-SF	6
Li (2022)	China	self-report	19.34 ± 1.362	59.50%	949	Students from 2 undergraduate institutions and 2 junior colleges	0.442	Problematic Mobile Social Media Use Assessment Questionnaire for Adolescents	CTQ-SF	7
Hu (2020)	China	self-report	N/A	53.82%	663	College students	0.381	MPATS	CTQ-SF	6
Cao et al. (2021)	China	self-report	15.6 ± 1.8	58.3%	532	Middle schools	0.36	Problematic Mobile Social Media Use Assessment Questionnaire for Adolescents	CTQ-SF	5
Xiang et al. (2023)	China	self-report	12.93 ± 2.54	49%	1951	One primary school, two middle schools, and one high school	0.209	MPA	CTQ-SF	6

(continued)

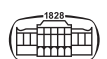


Table 2. Continued

First author	Geographic region	Research design	Ages	Female%	Samples	Samples source	Measurement			JBI score
							r	IA	Childhood trauma	
Geng et al. (2022)	China	self-report	15.96 ± 0.46	51%	965	Public high schools	0.28 0.23	The Smartphone Application-Based Addiction Scale	CTQ-SF	6
Zhang (2020)	China	self-report	13.95 ± 1.1	52.20%	903	Three middle schools	0.23	IADDS	CTQ-SF	6
Wei et al. (2020)	China	self-report	N/A	55.77%	1,162	Two universities	0.16	IAS	CTQ-SF	6

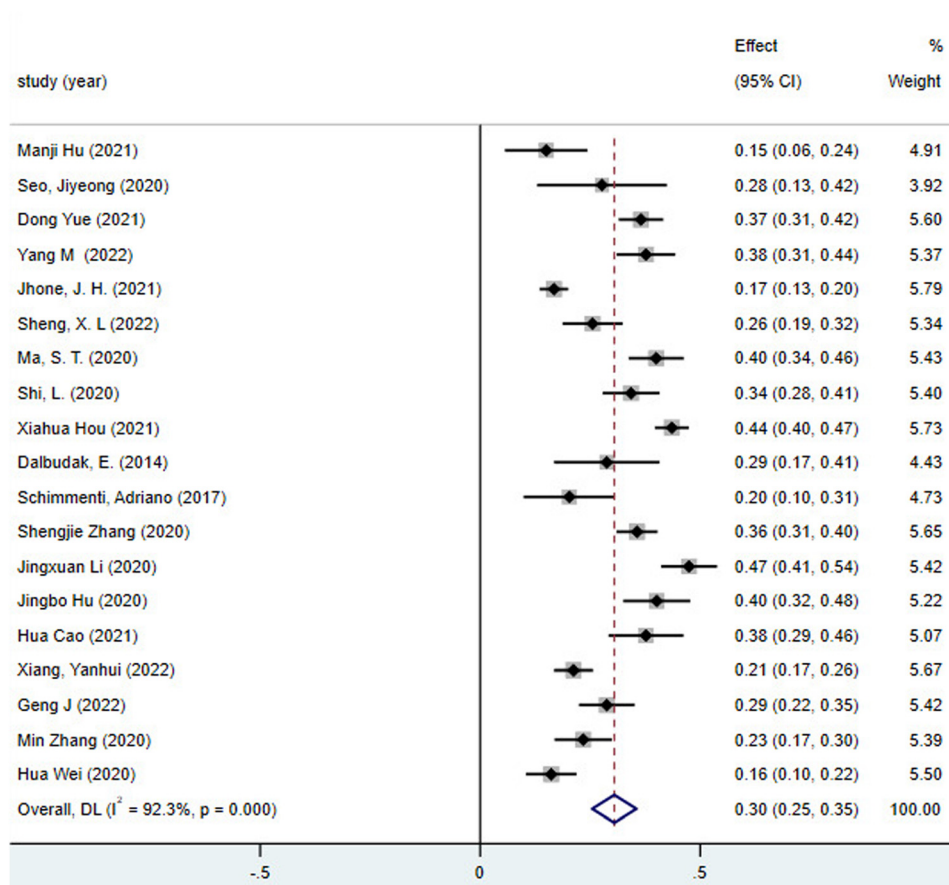


Fig. 2. Forest plot of the relationship child trauma and internet addiction

Region also moderated the relationship between childhood trauma and internet addiction. The results showed that the associations varied between China and the rest of the world. In contrast, neither the source of the sample (secondary school students vs. college students) nor the age of the participants moderated the association between childhood trauma and internet addiction.

Multiple regression analysis

Whether gender moderates the relationship between childhood trauma and internet addiction was explored primarily

through meta-regression analysis. According to the results of the statistical analysis, the relationship between childhood trauma and internet addiction was not affected by sex ($b = 0.002739$, 95% CI $[-0.0065, 0.0120]$, $p = 0.540$).

Publication bias and sensitivity analysis

As shown in the funnel plot (Fig. 3), the effect sizes were symmetrically distributed on either side of the mean effect size, indicating a low risk of publication bias in this study. However, the figure also reveals that Egger’s test is needed for validation, as some studies deviated from the confidence



Table 3. Results of subgroup analysis of the meta-analysis of childhood trauma and Internet addiction

	Q_{BET}	k	n	r	95% CI	Q_w	I^2
Sample size	9.71**						
<500		4	1,248	0.20	(0.10,0.31)	3.98	24.60%
500–1,000		9	7,605	0.23	(0.17,0.30)	43.09***	81.40%
≥1,000		6	12,545	0.30	(0.26,0.36)	154.09***	96.80%
Sample source	1.77						
middle school student		12	14,846	0.28	(0.22,0.33)	97.52***	88.70%
College student		6	6,539	0.35	(0.25,0.45)	75.01***	93.30%
region	7.67**						
China		15	17,478	0.32	(0.27,0.37)	151.6***	90.50%
Other regions		4	3,920	0.21	(0.15,0.27)	5.49	45.30%
Age	2.51						
12–15		7	9,298	0.27	(0.20,0.34)	61.98***	90.30%
15–18		3	3,263	0.34	(0.29,0.39)	3.82	47.70%
≥18		3	2,808	0.35	(0.23,0.46)	19.95***	90.00%
Internet addiction measurement tools	12.27**						
IAS		9	12,300	0.26	(0.22,0.34)	55.9***	85.70%
IGUESS		2	1847	0.20	(0.10,0.29)	2.02	50.40%
Problematic Mobile Social Media Use Assessment Questionnaire for Adolescents		2	1871	0.43	(0.33,0.53)	3.25	69.20%
others		6	5,380	0.33	(0.24,0.42)	73.74***	93.20%
Childhood trauma measurement tool	18.13***						
CTQ-SF		3	15,038	0.32	(0.27,0.37)	152.09***	90.10%
others		16	6,340	0.18	(0.14,0.22)	2.31	13.40%
JBI score	124.82***						
5		5	2,263	0.32	(0.28,0.36)	37.04***	47.80%
6		8	11,442	0.23	(0.21,0.25)	37.83***	90.50%
≥7		6	7,693	0.40	(0.29,0.31)	50.59***	82.00%

Q_{BET} : Between-group effect (QBET); Q_w : Homogeneity test within each group; k : Number of included studies; n : Included sample size. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

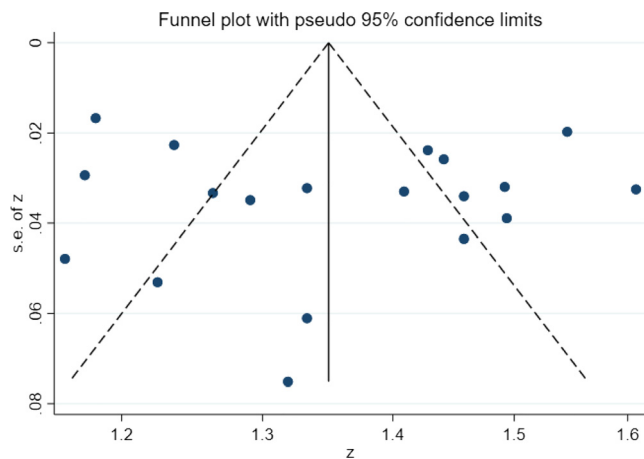


Fig. 3. Funnel Plot of the child trauma and international addiction

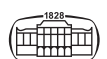
interval of the funnel plot. The Egger test did not reveal significantly publication bias ($b = 1.172$, 95% CI $[-4.081, 6.436]$, $p = 0.644$). In order to investigate the potential influence of outliers, we also used the the leave-one-out method for sensitivity analysis. As shown in Appendix B, the middle vertical line at 0.30 indicates the total combined effect size, and the two vertical lines on the sides at 0.25 and 0.35 indicate the 95% confidence interval range of the total

effect size. The dot corresponding to each study represents the combined effect size of the remaining studies after that study was deleted. The results showed that the r values and 95% CI barely changed after deleting studies one at a time. All the study results were still close to the pooled results, and the deviation range did not exceed the confidence interval, indicating that the results are stable.

DISCUSSION

The relationship between childhood trauma and internet addiction

The results of this meta-analysis further confirmed the positive correlation between childhood trauma and internet addiction, consistent with previous studies. Traumatic experiences in early childhood, especially neglect and abuse, can lead to a higher risk of pathological internet use in adolescents (Dalbudak et al., 2014). This may be because adolescents who experience adverse childhood experiences tend to feel less family warmth, have lower self-esteem, have lower self-worth and are more likely to develop addiction problems (Jhone et al., 2021; Hu, 2020; Cao et al., 2021). Specifically, adverse environments can lead to increased negative emotions, cognitive biases, and reduced social



relationships among adolescents, and adolescents are at high risk for emotional regulation disorders (Yang et al., 2022; Xiang et al., 2023; Geng et al., 2022). Adolescents overuse the internet to satisfy the need to be loved and connected and use the virtual world to cope with isolation and obtain social support, thus self-medicating negative emotions and ultimately leading to the emergence of internet addiction behaviours (Dong et al., 2021; Ma, Huang, & Ma, 2020a, b).

Moderating effects

The moderating role of childhood trauma measurement tools. Childhood trauma measurement instruments may have moderated the positive association between childhood trauma and internet addiction. The CTQ-SF showed the strongest positive correlation with internet addiction, while the other tests showed a lower positive correlation with childhood trauma. However, it is worth noting that most of the studies included in this meta-analysis used the CTQ-SF to measure childhood trauma, with only three studies using other scales. Thus, the relationship between child trauma and children's levels of internet addiction may not be fully reflected by these results.

The moderating effect of internet addiction measurement. The Internet Addiction Measurement Instrument moderated the relationship between childhood trauma and internet addiction. The correlation between childhood trauma and internet addiction was strongest when internet addiction was measured using the Adolescent Mobile Media Use Questionnaire. The association between childhood trauma and internet addiction was weakest when internet addiction was assessed using the IGUESS. This finding shows that the relationship between childhood trauma and internet addiction is influenced by the internet addiction measurement tool. Although the issue of internet addiction has been increasingly mentioned, the current definitions of internet addiction remain inconsistent, leading to various measures of and differences in internet addiction. The IGUESS was used to measure problematic internet use. This measurement tool is a Korean regional scale that was developed based on the fifth edition of the Diagnostic Statistical Manual of Mental Disorders to assess the barriers to the use of online games by adolescents in community and primary care centres (Jo et al., 2018). Researchers in China have developed scales such as the MPAT, MPATS, and the Adolescent Internet Abuse Scale based on the DSM-IV criteria for psychoactive substance addiction and pathological gambling, but these scales may have some differences in the number of dimensions, number of items, and cultural fit (Harris et al., 2020). The Internet Addiction Test for Adolescents (IAT-20) is an internet addiction assessment that is specifically designed for the adolescent population. The 20 items are scored based on a five-point scale (Tan et al., 2016; Xu et al., 2020). The IAT-20 has been used in many countries and has good reliability and validity. This finding shows that the IAT-20 can be adapted to several national contexts. Several researchers have found that different tools for

measuring internet addiction produce different results; – i.e., there is a low level of consistency between assessments made with different tools. Therefore, the use of measurement tools should have high reliability and validity and be based on a sound theoretical foundation appropriate for the purpose and population of the study. It is also evident from the heterogeneity of the measurement instruments that future studies should use common criteria to identify internet addiction whenever possible, thereby reducing potential variability.

The moderating role of gender. As shown by the meta-regression results, there was no significant moderating effect of sex on the relationship between childhood trauma and internet addiction. This may be related mainly to the gender difference in internet use. Relatively speaking, girls' internet use preferences focused more on individual emotional and private expressions, while boys focused mainly on instrumental and public expression aspects. For example, males prefer to use the internet for entertainment, whereas females prefer to use it for building and maintaining relationships (Dong et al., 2019; Jiang & Zhao, 2016). With the continuous development and improvement of internet technology, the internet has satisfied the need for instant communication and socialization while providing entertainment and stimulation-seeking functions that are equally attractive to different gender groups (Coyne et al., 2020). Therefore, there was no significant sex difference between childhood trauma and internet addiction.

Regional regulation effect. Regional differences moderated the association between childhood trauma and internet addiction. Specifically, the association between childhood trauma and internet addiction was strongest in China, which may be due to cultural differences. Previous studies revealed that region affects the prevalence of internet addiction among adolescents. Previous studies have shown that lower family functioning predicts internet addiction and that a warm family atmosphere is a protective factor against adolescent internet addiction (Huang, Lu, & Liu, 2009; Ko et al., 2007). After the reform and opening up, the proportion of urban left-behind children among Chinese children increased as a large number of people flocked from the economically underdeveloped western region to the economically developed eastern region. Children who are left behind because both or one parent is away from work or studies for more than six months must be cared for by nannies, grandparents, other relatives, or nonrelatives on a long-term basis. Research findings suggest that left-behind children have sufficient economic means to access the internet due to the special nature of their upbringing, lack of parent–child education, and school and social environment; moreover, if they are not properly guided in the process of using the internet, left-behind children are more likely to become addicted to the internet and develop various deviations (Ge, Se, & Zhang, 2014; Liu et al., 2023; Yates, Gregor, & Haviland, 2012). In China, adolescents who are under more academic pressure are more inclined to relieve their stress through the internet,



and as quality education and social competition intensify, many parents or guardians may realize that physical abuse no longer fits the educational model of contemporary society and is replaced by scolding, intimidation, and interference. As parents go out to work or are busy, they have less time to spend with their children. Actions such as parental neglect or even cold violence can cause abnormal mood swings in adolescents and may even lead to negative emotions that are difficult to regulate. Some adolescents solve or alleviate their emotional problems by indulging on the internet. These results suggest that there is an urgent need for child trauma intervention in China. In addition, as the number of migrant workers in poor areas of China increases and the number of children left behind increases, government planners should also consider allocating more resources for interventions in rural areas of China.

LIMITATIONS AND PROSPECTS

The positive correlation between internet addiction and childhood trauma was further confirmed in the present study. This meta-analysis has several limitations. First, few high-quality studies were included in this study, and the overall quality of the literature needs to be improved. In future studies, additional high-quality studies are needed to further explore the relationship between childhood trauma and internet addiction. Second, most of the studies included in this meta-analysis were cross-sectional studies, and most of the data were self-reported by adolescents, which could lead to social desirability bias. The widespread use of cross-sectional studies may also mean that childhood trauma was assessed retrospectively and that the association between internet addiction and childhood trauma may reflect common methodological biases. Longitudinal research should also be the focus of our future research. Finally, in the subgroup analysis, due to the inadequacy of our study design, this part of the content was not preregistered during the preregistration stage. In addition, when performing a subgroup analysis, because the same variance is explained by many different variables, the analyses are not adjusted for each other, which is also a limitation. However, further enrichment of the related literature is needed in the future to confirm the robustness of the results of the subgroup analysis of this study.

CONCLUSION

The results of the meta-analysis further confirmed the positive association between internet addiction and childhood trauma. The relationship between childhood trauma and internet addiction was moderated by instruments measuring childhood trauma and internet addiction, and the relationship was not affected by sex or age. To determine the temporal relationship between childhood trauma and internet addiction, longitudinal studies should be performed in the future. In addition, communities and

parents need to pay more attention to adolescents' childhood experiences and family environment formation to more effectively prevent internet addiction and to develop strategies to reduce the impact of childhood trauma on adolescents.

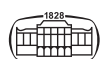
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Appendix A. Quality assessment of the studies reviewed

Item	Manji Hu et al.	Seo, Jiyeong et al.	Dong, Xue et al.	Yang et al.	Jhone, J. H. et al.	Sheng, X. L. et al.	Ma, S. T. et al.	Shi, L. et al.	Xiaohua Hou	Dalbudak, E. et al.	Schimmenti, A.	Shengjie Zhang	Jingxuan Li	Jingbo Hu	Hua Cao et al.	Xiang, Yanhui	Geng J et al.	Min Zhang	Hua Wei et al.
1 Define the source of information (survey, record review)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
2 List inclusion and exclusion criteria for exposed and unexposed subjects (cases and controls) or refer to previous publications	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
3 Indicate time period used for identifying patients	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
4 Indicate whether or not subjects were consecutive if not population-based	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
5 Indicate if evaluators of subjective components of study were masked to other aspects of the status of the participants	Y	Y	Y	Y	N	Y	N	N	Y	N	N	N	N	N	N	N	N	N	
6 Describe any assessments undertaken for quality assurance purposes (e.g., test/retest of primary outcome measurements)	N	N	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N	N	N	
7 Explain any patient exclusions from analysis	N	Y	N	Y	N	Y	N	N	Y	N	N	Y	Y	N	N	Y	Y	Y	
8 Describe how confounding was assessed and/or controlled	N	N	Y	N	Y	N	Y	Y	Y	N	N	N	Y	N	N	N	N	Y	
9 If applicable, explain how missing data were handled in the analysis	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
10 Summarize patient response rates and completeness of data collection	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	
11 Clarify what follow-up, if any, was expected and the percentage of patients for which incomplete data or follow-up was obtained	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
Total score	6	5	7	7	6	7	7	5	8	5	5	6	7	6	5	6	6	6	

Note: Y: yes, N: no or not mentioned, scoring for each item: Yes = low risk of bias (0 points); No = high risk of bias (1 point); Since no follow-up design was conducted in the included studies, item 11 is not evaluated; <3 was divided into low-quality papers, 4-7 was divided into medium-quality papers and 8-11 was divided into high-quality papers.



Appendix B. Sensitivity analysis

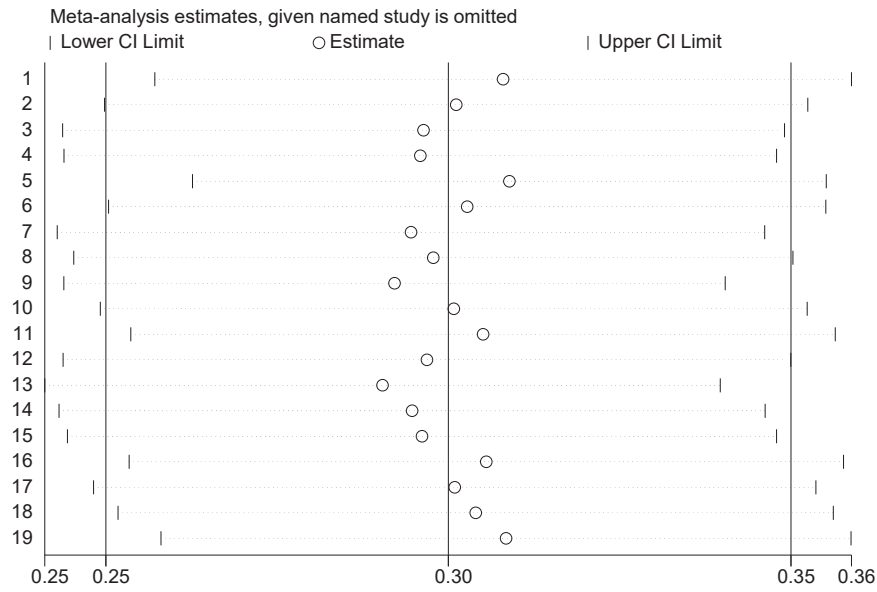


Fig. A1. Sensitivity analysis of Internet addiction and childhood trauma

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