




The More Internet Access, the More Mental Symptoms Students Got, the More Problematic Internet Use They Suffered: a Meta-analysis of Mainland Chinese Adolescents and Young Adults

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Abstract

The traditional view is that mental symptoms and problematic Internet use are positively related. Still, other researchers have questioned this view, and they believe that mental symptoms are negatively associated with problematic Internet use. Since then, this controversy has continued yet. The current study attempts to use meta-analysis to explore the relationship between mental symptoms and problematic Internet use in mainland Chinese students to provide a reliable basis for resolving this dispute. Sixty-three articles were included in this study, including 66 sample sizes and 47,968 subjects. It found that mental symptoms are positively correlated with problematic Internet use ($r = .288$, 95% confidence interval [.255, .320]). The correlation is affected by regions. Compared with coastal areas, problematic Internet users in the non-coastal areas are more likely to be affected by mental symptoms. In addition, gender differences also significantly affect the relationship between mental symptoms and problematic Internet use. The correlation coefficient between mental symptoms and problematic Internet use of girls is significantly higher than that of boys. Moreover, year also significantly affects the relationship between mental symptoms and problematic Internet use—the correlation increases by growing years.

Keywords Meta-analysis · Problematic Internet use · Mental symptoms

According to data from Internet World Stats (IWS), the number of Internet users in the world continued to grow at a high speed from 2000 to 2022. In North America, the growth rate is 222% from 2000 to 2022, the figure is 608% in Europe, and the figure has increased by 2341% in just 22 years in Asia. By 30 June 2021, the number of Internet users globally has reached 5.25 billion, accounting for 66.2% of the world's population. Among all

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countries and regions, the Chinese mainland has the highest proportion of Internet users in Asia, accounting for 35.7% of all Asian Internet users (Internet World Stats Usage and Population Statistics, 2022). Among the netizens in the Chinese mainland, students are the most, accounting for 23.7% (China Internet Network Information Center, 2020). The rapid development of the Internet has facilitated students' learning, especially during the COVID-19 pandemic. By March 2020, the number of online education users in the Chinese mainland had reached 423 million. By 11 May, the number of visitors on the Internet cloud platform for primary and secondary schools in the Chinese mainland had reached 2.073 billion. In the first half of 2020, under the guidance and promotion of the policy of "Classes suspended but learning continues," 282 million students on the Chinese mainland generally turn to online courses (China Internet Network Information Center, 2020). However, if students use the Internet problematically, their academic achievement, physical and mental health, peer relationship, and teacher-student relationship may be seriously affected (Jia et al., 2018). Therefore, how to control and reduce students' problematic Internet use has become a hot issue for scholars.

Problematic Internet use (PIU) is defined as a social, mental phenomenon characterized by mental distress and physiological discomfort caused by prolonged use of social networks for a long time and high intensity (Moreau et al., 2015). Based on whether researchers place more emphasis on addiction, compulsion, or other general aspects, there are some inconsistencies in terms and definitions when describing problematic Internet use, compulsive Internet use, pathological Internet use, Internet addiction, etc. (Anderson et al., 2016; Rial, Gomez, et al., 2015; Rial, Gómez, et al., 2015). For example, referring to uncontrollably emotional and behavioral manifestations, some studies hold the opinion that problematic Internet use shares many similarities with substance-related addiction, so it tends to seem like Internet addiction (Ko et al., 2009). Also, some research results emphasize the compulsiveness of using the Internet and loss of control in attending Internet activities (Thorsteinsson & Davey, 2014). However, these addicted compulsive and pathological related terms seem severe and will cause some social alarm in a non-clinical context (Rial et al., 2015; Rial, Gomez, et al., 2015). Thus, problematic Internet use is the most prudent and orthodox term among similar academic names (Rial et al., 2015a, 2015b). This article aims at non-clinical university students rather than those with overt clinical symptoms. Using the Internet in this group may produce inevitable negative consequences. Its symptoms are only mild and moderate psychological and physiological symptoms (anxiety, depression, etc.). It rarely develops into cognitive, emotional, or personality disorders. Given all of the analyses above, "Problematic Internet Use" adheres most to the core of this study and will be used in this paper.

Mental symptoms (MS) are symptoms of mental disorders. From the theoretical point of view, only mental symptoms severe to a certain degree can be recognized as mental abnormalities. Thus, even ordinary people can own varying degrees of mental symptoms. This paper mainly studies the mental symptoms of non-clinical groups.

Scholars have explored the formation mechanism of problematic Internet use from different perspectives, such as neurobiological basis, individual psychology, and social culture (Burnay et al., 2015; Lei, Cheong, et al., 2018; Lei, Li, et al., 2018; Li et al., 2018; Li et al., 2020; Shaw & Black 2008). A large number of scholars have explored the formation mechanism of problematic Internet use from the perspective of individual psychology. In particular, the relationship between mental symptoms and problematic Internet use has drawn extensive attention from researchers. Previous studies have found that mental symptoms significantly correlate with problematic Internet use (Elhai et al., 2020; Lei et al., 2020). The social displacement hypothesis holds that problematic Internet use reduces the time

for individuals to participate in social interactions with family and friends. Virtual communication gradually replaces face-to-face communication, leading to an increase in mental symptoms of individuals (Kraut et al., 1998). In addition, according to the mood enhancement hypothesis, individuals decide the time and type of problematic Internet use according to their emotional state. In order to eliminate negative emotions such as stress, loneliness, and depression, individuals will participate more in online chats and online games (Bryant & Zillmann, 1984; Ke & Wong, 2018; Whang et al., 2003). Significantly, children and adolescents will exhibit more adverse sleeping outcomes if they stay more time in front of the screen (Hale & Guan, 2015). However, some researchers hold the opposite view, and they suggest that mental symptoms are negatively correlated with network activities (Kraut et al., 2002; Morahan-Martin et al., 2003). Eden et al. (2021) proved that some problematic Internet-based media use, such as broadcast television, showed no positive relationship to depression and poor sleep quality. The Internet may provide an environment for social interaction and interpersonal relationship development, and the Internet can reduce the mental symptoms of individuals.

Therefore, there is still a debate about whether mental symptoms and problematic Internet use are positively or negatively correlated. One of the reasons for this debate is the small number of participants in a single investigation. The current study used a meta-analysis method to integrate previous empirical studies on mental symptoms and problematic Internet use.

Different studies on the relationship between mental symptoms and problematic Internet use may also be caused by the differences in measurement tools and demographic variables used. Given this, this study assumed that the relationship between mental symptoms and problematic Internet use would be affected by measurement tools and demographic variables (region, grade, and gender).

Measures of Mental Symptoms and Problematic Internet Use

The very early measurement of testing an individual's mental health is the Global Assessment Scale (GAS; Endicott et al., 1976). It has been proved reliable in a range of chronically mentally ill people (Jones et al., 1995). Later, the Global Assessment of Functioning (GAF), which was designed by DSM-III-R and confounded both symptomatology and social functioning, was published for accurate and quick evaluation of the severity of mental symptoms (American Psychiatric Association, 1987). This scale was also widely used in mentally ill patients. Nowadays, the American Academy of Pediatrics recommends the PHQ-9 (Patient Health Questionnaire; Johnson et al., 2002; Spitzer et al., 1999) to measure the emotional well-being of adolescents and screen depression in young people. In China, it can be found that the most widespread mental symptom measurement tool used by researchers is SCL-90 (Symptom Checklist-90). SCL-90, compiled by Derogatis in 1973 and translated into China by Wang Zhengyu (Wang, 1984), is mainly used to measure perceived symptoms and severity of mental symptoms. SCL-90 is the primary test tool in the general survey of students' mental health conducted by many colleges and universities in China. SCL-90 included 90 items, which were divided into 10 factors, including somatization, obsessive interpersonal relationship, depression, anxiety, hostility, terror, paranoia, psychosis, sleep, and diet. Each item is scored by 5 points. The factor mean score is the total number of items included in a factor divided by the number of items. The higher the score, the more mental symptoms.

In a global perspective of measuring the related questions of problematic Internet use, Rial, Gómez, et al. (2015), Rial, Gomez, et al. (2015)) summarized and listed 56 principal scales that were commonly used in the previous studies. However, these instruments suggested a huge degree of heterogeneity. The most relevant assessment tools used to measure problematic Internet use in China are also diverse. The following scales are mainly used. First, some scholars used IAT (Internet Addiction Test) compiled by Young in 1998. The scale, consisting of 20 items on a scale of 1 (almost none) to 5 (always), explores the impact of problematic Internet use on an individual's daily life, social work efficiency, sleep pattern, and perception. A higher score indicates a higher degree of problematic Internet use. Second, others used the Revised Chinese Internet Addiction Scale (CIAS-R, Chen et al., 2003), which comprises 26 items classified into two dimensions: core symptoms of IA (three factors: compulsive Internet use, IA withdrawal response, and IA tolerance) and related problems of IA (two factors: interpersonal and health problems, and time management problems). Items are rated on a 4-point Likert scale, with scores reflecting the tendency toward IA (Chen et al., 2003). Third, some other self-written problematic Internet use questionnaires are also used. Different assessment tools of problematic Internet use have different theoretical bases, dimensions, and items of questions, which affects the relationship between mental symptoms and problematic Internet use to a certain extent. Therefore, this study intends to analyze the adjustment effect of measurement tools on problematic Internet use.

Demographic Variables as Moderators

Region

China can be delineated into coastal and non-coastal areas (Li et al., 2020). Studies have found that there is a low positive correlation between mental symptoms and problematic Internet use of students in coastal areas of China (Huang et al., 2008), while there is a moderate positive correlation between mental symptoms and problematic Internet use of students in non-coastal areas (Bao et al., 2014). Other studies have found a moderate positive correlation between mental symptoms and problematic Internet use among students in coastal and non-coastal regions of China (Dai, 2007; Guo & Guo, 2011). Thus, this study intends to explore the differences in the correlation coefficient between mental symptoms and problematic Internet use among students in different regions.

Grade

Grade is a moderating variable that affects the relationship between mental symptoms and problematic Internet use. Studies have found a low positive correlation between mental symptoms and problematic Internet use in middle school students (Huang et al., 2008), while there is a moderate positive correlation between mental symptoms and problematic Internet use in college students (Bao et al., 2014). In addition, some studies have found that the relationship between mental symptoms and problematic Internet use of students in different school periods is of low positive correlation (Huang et al., 2010). Given this situation, this study intends to analyze the relationship between mental symptoms and problematic Internet use among different grade-level groups.

Gender

Gender is a moderating variable that affects the relationship between mental symptoms and problematic Internet use. Previous studies showed that there was a low positive correlation between male mental symptoms and problematic Internet use (Su et al., 2006), while there was a moderate positive correlation between female mental symptoms and problematic Internet use (He et al., 2011). Other studies have shown a moderately positive correlation between mental symptoms and problematic Internet use in both male and female students (Zhao et al., 2014). This study intends to explore the differences in the correlation coefficient between mental symptoms and problematic Internet use among students of different genders.

Year

Year is a moderating variable that affects the relationship between mental symptoms and problematic Internet use. Previous studies have shown that the correlation between mental symptoms and problematic Internet use increases with increasing years (Chen & Song, 2017; Chen et al., 2014; Feng & Wang, 2011). Other studies have shown that the correlation between mental symptoms and problematic Internet use decreases by growing years (Han et al., 2007; Ni et al., 2006; Qiu et al., 2008). Therefore, this study will explore the differences in mental symptoms and problematic Internet use among students in different years.

To sum up, the main objective of the current study is to use meta-analysis to explore the main correlation effects of mental symptoms and problematic Internet use and also to identify the moderating effects of measurement tools, region, grade, gender, year, and other factors on mental symptoms and problematic Internet use.

Method

Literature Search

We used databases to search the related studies on mental symptoms and problematic Internet use in China from January 1998 to March 2022, including CNKI, Wanfang Data, Chongqing VIP Information Co., Ltd. (VIP), Baidu scholar, ProQuest dissertations, Taylor & Francis, Springer, Web of Science, Google Scholar, EBSCO, and PsycINFO. The main search terms for mental symptoms are Mental Symptoms, psychological problems, mental health, psychological health, and SCL-90. The search terms for Internet overuse are Problematic Internet Use, Internet addiction, Internet dependence, excessive Internet use, compulsive Internet use, Internet addiction disorder, and pathological Internet use. After initial screening, 216 articles were selected.

Then, we screened the literature by the following criteria (the flow chart of the article selection process is depicted in Fig. 1): (a) The article used both the mental symptom scale and the problematic Internet use scale and reported the correlation coefficient between dimensions or total scores of one scale and dimensions or total scores of another scale; (b) in this paper, Pearson's product-moment coefficients or t value and F value which can be converted into R are clearly reported; (c) the sample size in the

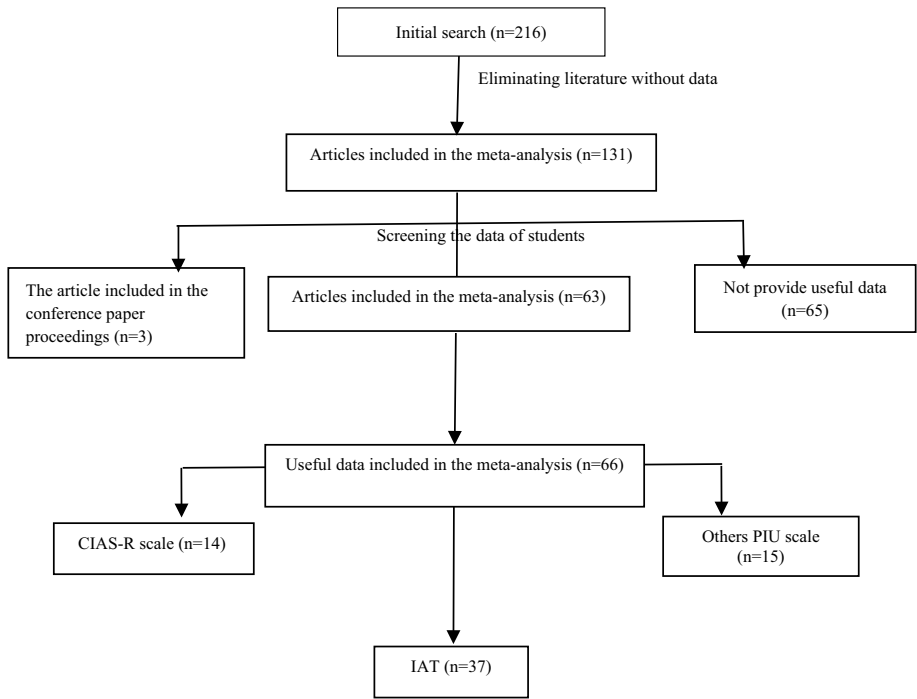


Fig. 1 Flow chart of the study selection process

article is apparent; (d) the research object of this paper is the student group, excluding data of other non-student groups; (e) the research object is non-clinical people, excluding the data of diseases and crime groups; (f) only professional academic journals were used for data duplication. By reading the literature titles, abstracts, and full text, 63 references (including 66 samples) met the inclusion criteria after eliminating repeated publications and the absence of precise data.

Coding Variables

We coded the features of the collected literature, including author information, year of publication, grade, sample size, correlation coefficient between mental symptoms and problematic Internet use, mental symptom scale, problematic Internet use scale, and the proportion of women. It is shown in Table 1. The extraction of effect size follows the principles: (a) encoded the correlation coefficients of mental symptoms and problematic Internet use; (b) independent samples were coded once. If multiple independent samples are reported in the same article, they were coded separately; (c) when calculating the effect size of each category, the data used did not overlap. It means that each original data only appeared once under each category to ensure the independence of effect size calculation.

Table 1 Characteristics of the studies included in the meta-analysis

Name (year)	Region	Grade ^a	<i>N</i>	<i>r</i>	MS scale	PIU scale	Female%
Bao et al. (2014)	Non-coastal	1	2377	0.237	Others	IAT	51.96%
Chen and Song (2017)	Coastal	2	80	0.5	SCL-90	IAT	50.00%
Chen et al. (2007)	Coastal	1	348	0.249	SCL-90	Others	54.31%
Chen et al. (2014)	Non-coastal	1	4870	0.415	SCL-90	IAT	49.69%
Dai (2007)	Coastal	2	269	0.294	Others	CIAS-R	57.62%
Dai and Sun (2008)	Coastal	2	269	0.294	Others	CIAS-R	57.62%
Feng and Wang (2011)	Coastal	2	1896	0.318	Others	Others	53.43%
Feng et al. (2006)	Non-coastal	1	1784	0.14	SCL-90	IAT	65.47%
Fu et al. (2009)	Coastal	2	62	0.136	SCL-90	IAT	48.39%
Gao and Han (2006)	Non-coastal	1	712	0.151	SCL-90	IAT	50.00%
Gao et al. (2008)	Coastal	1	739	0.342	SCL-90	CIAS-R	32.88%
Guo and Guo (2011)	Non-coastal	2	111	0.255	Others	CIAS-R	45.95%
Guo et al. (2008)	Non-coastal	3	3508	0.462	SCL-90	CIAS-R	54.53%
Han et al. (2007)	Non-coastal	1	98	0.448	SCL-90	IAT	50.00%
He et al. (2011)	Coastal	1	617	0.26	SCL-90	CIAS-R	63.05%
Hou (2005)	Coastal	1	554	0.101	SCL-90	IAT	40.07%
Hu (2011)	Coastal	1	562	0.116	SCL-90	IAT	48.58%
Huang et al., 2008)	Coastal	2	200	0.13	SCL-90	IAT	30.00%
Jia (2021)	Non-coastal	2	1741	0.403	Others	Others	49.74%
Jiang and Li (2019)	Non-coastal	2	733	0.41	Others	CIAS-R	65.48%
Li (2006)	Non-coastal	1	266	0.125	SCL-90	Others	53.38%
Li (2008, E1)	Coastal	1	191	0.358	SCL-90	CIAS-R	49.21%
Li (2008, E2)	Coastal	1	191	0.402	SCL-90	IAT	49.21%
Li (2009)	Coastal	2	320	0.246	SCL-90	IAT	57.19%
Li and Liu (2005)	Coastal	2	80	0.253	SCL-90	IAT	20.00%
Li et al., (2006)	Non-coastal	1	1227	0.191	SCL-90	IAT	67.16%
Li (2008, E1)	Coastal	1	654	0.1	SCL-90	Others	54.59%
Li (2008, E2)	Coastal	1	654	0.332	SCL-90	Others	54.59%
Lin (2006)	Coastal	1	340	0.297	SCL-90	Others	54.71%
Liu and Wu (2004)	Coastal	2	107	0.336	Others	IAT	41.12%
Ni et al. (2006)	Non-coastal	1	261	0.669	SCL-90	IAT	40.23%
Pan and Zheng (2008)	Coastal	1	50	0.421	SCL-90	IAT	32.00%
Qiu et al. 2008)	Coastal	1	384	0.305	SCL-90	Others	36.72%
Ren (2014)	Non-coastal	2	584	0.25	SCL-90	IAT	45.38%
Ren (2015)	Non-coastal	1	353	0.35	SCL-90	IAT	30.59%
Su et al. (2006)	Coastal	1	432	0.138	SCL-90	Others	30.79%
Tong (2012)	Non-coastal	3	1947	0.166	SCL-90	IAT	47.00%
Wang (2006a)	Coastal	1	530	0.208	SCL-90	CIAS-R	57.36%
Wang 2006b)	Coastal	1	190	0.131	SCL-90	IAT	50.00%
Wang (2009)	Coastal	1	536	0.347	SCL-90	Others	39.74%
Wang and Huang (2007)	Non-coastal	1	313	0.116	SCL-90	IAT	50.00%
Wang and Li (2007)	Non-coastal	1	940	0.297	SCL-90	IAT	55.53%
Wang and Ren (2011)	Coastal	2	380	0.452	Others	IAT	55.00%
Wang et al. (2010)	Coastal	1	526	0.132	SCL-90	IAT	50.95%

Table 1 (continued)

Name (year)	Region	Grade ^a	<i>N</i>	<i>r</i>	MS scale	PIU scale	Female%
Wang et al. (2017)	Non-coastal	1	191	0.41	SCL-90	CIAS-R	78.53%
Wang et al.(2021)	Non-coastal	1	1040	0.46	SCL-90	IAT	60.00%
Wu (2010)	Non-coastal	1	501	0.57	SCL-90	CIAS-R	54.09%
Huang et al. (2010)	Coastal	3	304	0.071	SCL-90	Others	6.25%
Yang (2006)	Non-coastal	1	1271	0.348	SCL-90	Others	58.22%
Yang (2018)	Non-coastal	2	338	0.417	SCL-90	IAT	50.00%
Yang and Zheng (2008)	Non-coastal	1	1357	0.402	SCL-90	Others	54.53%
Yang and Chen (2009)	Non-coastal	1	1357	0.317	SCL-90	Others	54.53%
Yao (2011)	Non-coastal	1	365	0.145	SCL-90	CIAS-R	47.38%
Yao et al. (2005)	Non-coastal	1	648	0.414	SCL-90	IAT	37.50%
Ye (2015)	Coastal	2	200	0.13	SCL-90	IAT	50.00%
Yin (2008)	Non-coastal	2	781	0.253	SCL-90	IAT	59.92%
Yu (2008)	Coastal	1	963	0.073	SCL-90	IAT	40.60%
Zhang (2007)	Non-coastal	3	961	0.254	SCL-90	IAT	51.93%
Zhang et al. (2006a)	Non-coastal	1	752	0.237	SCL-90	IAT	55.59%
Zhang et al. (2006b)	Non-coastal	1	178	0.104	SCL-90	Others	50.00%
Zhang et al. (2011)	Coastal	2	832	0.218	Others	IAT	47.96%
Zhang et al. (2020)	Non-coastal	1	1353	0.475	SCL-90	CIAS-R	70.40%
Zhao et al. (2014)	Non-coastal	1	860	0.283	SCL-90	CIAS-R	50.00%
Zheng et al. (2007)	Coastal	1	122	0.348	SCL-90	IAT	50.00%
Zhou et al. (2015, E1)	Non-coastal	1	328	0.233	SCL-90	IAT	79.27%
Zhou et al. (2015, E2)	Non-coastal	1	280	0.225	SCL-90	IAT	59.64%

^a1 = university and graduate student; 2 = middle school student; 3 = mixed (1 and 2).

Effect Size Calculation

In this study, a meta-analysis of correlation coefficients was used (Borenstein et al., 2009). Pearson's product-moment coefficient *R* was used as the measurement value of the effect size. The result was Fisher *Z*-converted *R* values, and weights were calculated based on the sample size, while calculated 95% confidence intervals: $Z = 0.5 * \ln[(1 + r)/(1 - r)]$, the variance of *Z* is $V_Z = 1/n - 3$, the standard error of *Z* is $SEz = \sqrt{(1/n - 3)}$.

Data Processing and Analysis

A homogeneity test is required to test whether each study result represents a sample estimate of the total effect size. First, the homogeneity test provides the basis for using the fixed effects model or random effects model. If the test results show that the effect size is homogeneous, the fixed effects model will be used. If the heterogeneity is considerable, the random effects model should be selected. Secondly, the homogeneity test also provides the basis for the analysis of the regulatory effect, and the large heterogeneity indicates the existence of the regulatory effect (Lipsey & Wilson, 2001).

Results

Effect Size and Homogeneity Tests

In this study, 63 pieces of literature are included in the meta-analysis, which reflected the relationship between mental symptoms and problematic Internet use. They include 66 sample sizes and 47,968 subjects, and the number of subjects ranged from 50 to 4870. Table 2 shows 66 independent samples getting symptoms and problematic Internet use related homogeneity test, Q statistic value is 924.063, $P < .001$, $I^2 = 92.966$. It shows that literature exists heterogeneity, maybe due to the different measurement tools used in the literature, the source of the subjects, and the different sample sizes. There may be a moderating effect. According to the method provided by Lipsey and Wilson (2001), when the heterogeneity of the included literature is considerable, the random model must be used for analysis.

The random model was used to analyze the correlation between mental symptoms and Internet overuse. The results showed a significant correlation between mental symptoms and problematic Internet use, with a correlation coefficient of .288, 95% CI [.255, .320]. The Z -value of the relationship between mental symptoms and problematic Internet use is 16.367, $P < .001$, indicating that the relationship between mental symptoms and problematic Internet use is stable.

Moderator Analysis

As mentioned before, random effects models should also be used in mediating effects analysis. Meta-ANOVA analysis is suitable for analyzing the moderating effects of categorical variables, such as the type of region and the grade group. In contrast, meta-regression analysis is ideal for analyzing continuous variables' moderating effects, such as the proportion of females and year.

Meta-ANOVA Analysis

In order to deeply analyze the moderating effect of the relationship between mental symptoms and problematic Internet use, meta-ANOVA analysis was used to analyze the moderating effect of categorical variables (Table 3). We found that region has a significant moderating effect on the relationship between mental symptoms and problematic Internet use through data analysis.

Regarding region, the homogeneity test ($Q = 5.803$, $df = 1$, $P < .05$) showed that region had a regulatory effect on this correlation. The correlation coefficients between mental symptoms and problematic Internet use of subjects in coastal areas and non-coastal areas were .247 (95% CI = [.207, .287]) and .320 (95% CI = [.276, .363]), respectively. It indicates that $r_{\text{coastal areas}} < r_{\text{non-coastal areas}}$. For grade, the homogeneity test ($Q = .520$, $df = 2$, $P > .05$) showed that grade did not regulate the correlation. In terms of PIU measures, the homogeneity test ($Q = 4.348$, $df = 2$, $P > .05$) showed that PIU measures did not regulate the correlation.

Table 2 Random model of correlations between mental symptoms and problematic Internet use

<i>k</i>	<i>N</i>	<i>Mean r</i>	<i>95% CI for r</i>	<i>Homogeneity test</i>		<i>Tau-squared</i>		<i>Test of null (two-tailed)</i>		
				<i>Q(r)</i>	<i>P</i>	<i>Tau²</i>	<i>SE</i>	<i>Z-value</i>	<i>p</i>	
66	47,968	0.288	[0.255, 0.320]	924.063	0.00	0.019	0.005	0.136	16.367***	<0.001

P*<0.05, *P*<0.01, ****P*<0.001, the same as follows.

Table 3 Region and grade and problematic Internet use measures moderators of the association between mental symptoms and problematic Internet use

	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	5.803*						
Coastal areas		32	0.247	0.004	0.207	0.287	177.395***
Non-coastal areas		34	0.320	0.007	0.276	0.363	639.822***
Grade	0.520						
University		44	0.287	0.006	0.245	0.327	658.844***
Younger		18	0.303	0.004	0.257	0.349	79.949***
Mixed		4	0.247	0.041	0.051	0.426	174.642***
PIU measure	4.348						
CLAS-R		14	0.349	0.009	0.284	0.411	153.300***
IAT		37	0.273	0.007	0.227	0.318	506.737***
Others		15	0.269	0.005	0.216	0.320	122.810***

Meta-regression Analysis

To examine whether continuous variables (gender and year) moderate the effect sizes between mental symptoms and problematic Internet use, the r effect size was meta-regressed onto the percentage of female participants and year in each sample. In Table 4, meta-regression ($Q_{Model} [1, k = 66] = 21.082, P < .001$) demonstrated that the relation between mental symptoms and problematic Internet use was moderated by gender. The correlation between mental symptoms and problematic Internet use also increases with the number of females increasing. Meta-regression ($Q_{Model} [1, k = 66] = 129.485, P < .001$) demonstrated that the relation between mental symptoms and problematic Internet use was moderated by year. It means with the increase of year, the correlation coefficient between mental symptoms and problematic Internet use also increases.

Publication Bias

To examine whether the results were biased due to effect sizes from various sources, a funnel plot was drawn. It indicates that the 66 effect sizes were symmetrically distributed on

Table 4 Meta-regression analysis of year and gender

	Parameter	Estimate	SE	Z-value	95% CI for b
<i>Year</i>	β_0	-23.144	2.062	-11.224	[-27.186, -19.103]
	β_0	0.012	0.001	11.379	[0.010, 0.014]
$Q_{Model} (1, k = 66) = 129.485, P < 0.001$					
<i>Female (%)</i>	β_0	0.201	0.026	7.646	[0.149, 0.253]
	β_0	0.227	0.049	4.592	[0.130, 0.324]
$Q_{Model} (1, k = 66) = 21.082, P < 0.001$					

both sides of the average effect size, and Egger's regression (Egger et al., 1997) revealed no significant bias ($t(64) = 1.917, P > .05$). This result showed that the overall correlation between mental symptoms and problematic Internet use was stable in this study (Fig. 2).

Discussion

Relationship Between Mental Symptoms and Problematic Internet Use

Meta-analysis results showed a moderate positive correlation between mental symptoms and problematic Internet use, consistent with previous research results (Chen & Song, 2017; Jiang & Li, 2019). The more severe students' mental symptoms are, the more severe their problematic Internet use will be, supporting Davis's cognitive-behavioral model. Davis believes that the necessary factors for lousy behavior are diathesis and stress, which are medium-to-distal contributors. In the process of forming Internet overuse, mental symptoms play a role in diathesis. When the individual has mental symptoms such as depression, anxiety, and pressure, the necessary factor of problematic Internet use appears. When coupled with individual contact with network technology as a pressure source, it is very likely to lead to the behavior of problematic Internet use. Davis's cognitive-behavior theoretical model also suggested that maladaptive cognition is a core factor for adverse behaviors. Individuals with mental symptoms are prone to express more maladaptive cognitions so that they increase the level of individually problematic Internet use. Therefore, the more severe students' mental symptoms are, the more likely they will increase problematic Internet use.

At the same time, studies also show that the more profound the degree of problematic Internet use among adolescents, the more serious the mental symptoms will be, consistent with previous research results (Whang et al., 2003). It supports the social displacement hypothesis. The social displacement hypothesis reveals that excessive use of the Internet will hurt people's mental health. The problematic Internet use may make people develop

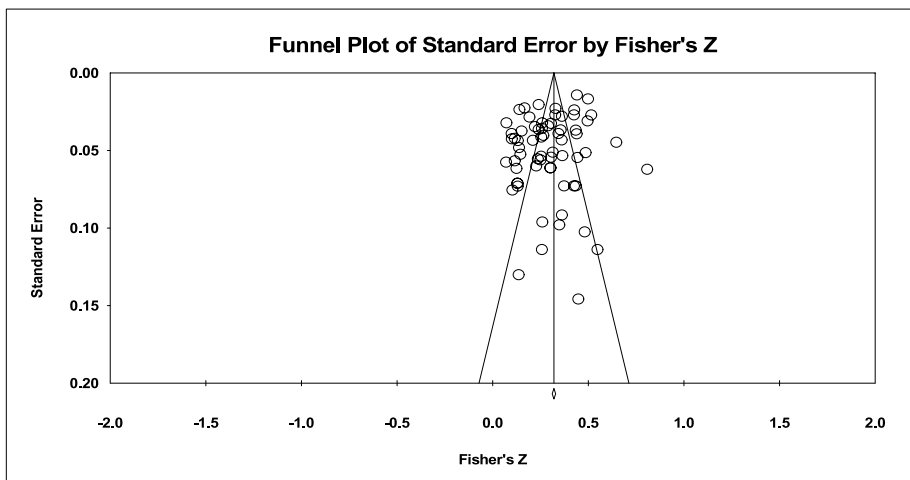


Fig. 2 Funnel plot of effect sizes of the correlation between mental symptoms and problematic Internet use

poor social relations instead of good social connections in real life. Weaker social links among people may lead to worse social communication results (Kraut et al., 2003). As a result, they are more likely to suffer disruption and trigger mental symptoms (Patterson and Kraut 1998). Therefore, the increase of students' Internet overuse will lead to more severe mental symptoms.

Moderating Effects

The Moderating Role of Region

Region moderated the relationship between mental symptoms and problematic Internet use. Mental symptoms' relation to students' problematic Internet use was stronger in non-coastal areas China than in coastal areas China. The reasons may be as follows: First, the level of economic development affects the relationship between the two (Fryers et al., 2005). Compared with the coastal areas, the economic growth in non-coastal areas is relatively backward, and mental health education is started later (Chen, 2010). However, adolescent students are more likely to produce mental symptoms due to the tremendous psychological and physiological changes (Chen, 2010; Fryers, et al., 2005). It may regulate the relationship between mental symptoms and problematic Internet use.

Second, studies have found that the imbalance of economic and social development in China's social transformation, through a series of conduction of social impact on the ecosystem, ultimately affects junior high school students' mental health level. From 1987 to 2013, the mental health level of junior middle school students in eastern coastal areas of China increased with age, while the mental health level of junior middle school students in non-coastal areas decreased with age (Wang & Yu, 2017). Thus, it regulates the relationship between mental symptoms and problematic Internet use.

Third, network communication motivation affects the relationship between them. Some studies have found that the motivation of Internet communication among students from non-coastal areas is significantly higher than that of students of coastal regions. It may be due to the high pace of living and learning in coastal areas so that teenagers often do not have much leisure time to use the Internet. While in non-coastal regions, the pace of life is slower, and there are fewer opportunities for learning and practice in real life, so teenagers have more leisure time to spend online (Chi, 2009). The motivation level of Internet communication also affects the relationship between mental symptoms and problematic Internet use.

The Moderating Role of Gender

This study found that gender moderated the link between mental symptoms and problematic Internet use. Mental symptoms' links to students' problematic Internet use were stronger for females than males. There may be two reasons: First, there are significant differences between genders in physiological characteristics and social roles. Girls' personality characteristics show a tendency of sensitivity, moodiness, and suspiciousness. They are more prone to psychological problems such as anxiety and terror (Zhang & Liu, 2017). Almost all the research evidence around the world shows that the mental health level of girls is lower than that of boys, and this gap gradually increases with the change of years (Yu & Wang, 2020), which may regulate the relationship between mental symptoms and problematic Internet use. Second, studies have shown that teenagers' problematic Internet

use is related to their leisure time activities. Active participation in family and outdoor activities can reduce the level of problematic Internet use. Compared with girls, boys were more likely to engage in active outdoor activities in their leisure time. Participation in outdoor activities was associated with a lower likelihood of problematic Internet use (Lin et al., 2009). Thus, gender can affect the relationship between mental symptoms and problematic Internet use.

The Moderating Role of Year

The current study found that year moderated the links between mental symptoms and problematic Internet use. That is, the relationship between mental symptoms and problematic Internet use increases as the years elapse. The reasons for this may be as follows: First, as the years go by, the percentage of mental symptoms goes up (Charlson et al., 2016). It indeed regulates the relationship between mental symptoms and problematic Internet use. Second, studies have shown that the time and frequency of Internet use of adolescents are positively correlated with problematic Internet use (Zhang et al., 2008). As the years go by, the Internet becomes more popular. Teenagers can use more ways to access the Internet, and the rate of problematic Internet use increases each year, which moderates the relationship between mental symptoms and problematic Internet use.

Implications of the Study

The meta-analysis results of mental symptoms and problematic Internet use inspire us that more effective policies are needed to reduce the harm of problematic Internet use. On the one hand, we need to prevent students' problematic Internet use and reduce the risk factors of Internet use. First, schools or communities need to carry out information to prevent teenagers' problematic Internet use. The most extensive form of preventing problematic Internet use is to provide students with factual information about problematic Internet use's adverse consequences (Alavi et al., 2012; Kwon, 2012). The study showed that students who attended lectures on the risks of problematic Internet use used the Internet more healthily than the control group (Korkmaz & Kiran-Esen, 2012). Secondly, countries or regions need to take some preventive measures against teenagers' Internet use. For example, in Hong Kong, China, most prevention programs aim to raise public awareness and enhance digital literacy. Its core content is to educate the public to minimize the adverse consequences of problematic Internet use on health (Chung et al., 2019). Mainland China has introduced policies to clean up and screen out cyber cafes around schools, coordinate network letters, and market supervision departments to further enhance the management of the network environment, strengthen the management of mobile phones, and prevent students from getting addicted to the Internet (Ministry of Education of the People's Republic of China, 2021). Since the Korean government established the first special clinic (Internet Addiction Prevention Center) to provide counseling services for pathological Internet use in 2002, more than 80 affiliated counseling centers have begun to offer counseling services for adolescents with pathological Internet use (Kwon, 2012). Relying on multiple preventions to reduce the risk factors of Internet use, we can reduce problematic Internet use of adolescents.

On the other hand, the results of the current study highlight improving students' mental health levels and enhancing the protective factors of Internet use. First, since mental symptom is the pathogenic factor of problematic Internet use, it is essential for teenagers

to improve life skills to promote their self-confidence and sense of achievement (Rial et al., 2018), so as to alleviate comorbid symptoms such as Internet addiction (Chung et al., 2019). Second, families, schools, and society should make all-around efforts to provide multiple psychological interventions for students, so as to reduce students' problematic Internet use tendency (Vondráčková & Gabrhelík, 2016). Studies have shown that family participation and parental supervision are important to prevent teenagers from overusing the Internet. Therefore, family-centered approaches, parent education, and initiatives to improve communication skills with adolescents can be used to help families reduce maladaptive family behavior (Throuvala et al., 2019). In addition, the formulation of national policies is also an important protective factor. For example, the Ministry of Education of China, in the key points of work in 2022, proposed that schools should strengthen and improve students' mental health education, implement students' mental health promotion plan, and do a good job in scientific identification, real-time early warning, professional consultation, and proper response (Ministry of Education of the People's Republic of China, 2022). Relying on multiple protection to improve mental health, we can reduce the problematic Internet use of teenagers.

Limitations and Future Studies

In this study, Egger's publication bias test was applied to the meta-analysis results. It found that the included articles did not have obvious publication bias and that the meta-analysis results were stable. This indicates that, compared with the results of studies based on a single sample group, the results of this study were more reliable, more representative, and more authentic.

Future studies could highlight the following aspects: (1) It is necessary to combine multiple methods and strategies to investigate the relationship between mental symptoms and problematic Internet use. For example, besides the self-evaluation method, other evaluation methods should be employed as well. (2) The samples should be collected from a broader population. Since the research subjects in this study were only students, the research subjects should be extended to social sectors in the future, such as the sector of workers and farmers. (3) Only the modulating effects of measurement tool, region, age, gender, and year were tested in this meta-analysis. In the future studies, other latent moderator variables may be subject to analysis. (4) Mainland Chinese researchers primarily performed cross-sectional studies while seldom conducting longitudinal research. Therefore, follow-up studies could be conducted in the future.

Conclusion

Through reviewing 66 sample sizes that had 47,968 student participants, meta-analysis results revealed that mental symptoms had a significant positive correlation with students' problematic Internet use. Furthermore, participants' region moderated this relationship. Compared with coastal areas, problematic Internet users in the non-coastal areas are more likely to be affected by mental symptoms. In addition, gender differences also significantly affect the relationship between mental symptoms and problematic Internet use. The correlation coefficient between mental symptoms and problematic Internet use of girls is significantly higher than that of boys. Moreover, the year also significantly affects the relationship between mental symptoms and problematic Internet use. With the increase of the

year, the correlation coefficient between mental symptoms and problematic Internet use also increases.

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Declarations

Approval and informed consent are not applicable for the current meta-analysis

Conflict of Interest The authors declare that they have no competing interests.

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