

The Association between Pathological Internet Use and Comorbid Psychopathology: A Systematic Review

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Key Words

Pathological Internet use · Internet addiction · Psychopathology · Depression · Anxiety · Attention deficit and hyperactivity disorder · Obsessive-compulsive symptoms · Social phobia · Hostility/aggression

Abstract

Background: Pathological Internet use (PIU) has been conceptualized as an impulse-control disorder that shares characteristics with behavioral addiction. Research has indicated a potential link between PIU and psychopathology; however, the significance of the correlation remains ambiguous. The primary objective of this systematic review was to identify and evaluate studies performed on the correlation between PIU and comorbid psychopathology; the secondary aims were to map the geographical distribution of studies, present a current synthesis of the evidence, and assess the quality of available research. **Sampling and Methods:** An electronic literature search was conducted using the following databases: MEDLINE, PsycARTICLES, PsychINFO, Global Health, and Web of Science. PIU and known synonyms were included in the search. Data were extracted based on PIU

and psychopathology, including depression, anxiety, symptoms of attention deficit and hyperactivity disorder (ADHD), obsessive-compulsive symptoms, social phobia and hostility/aggression. Effect sizes for the correlations observed were identified from either the respective publication or calculated using Cohen's *d* or *R*². The potential effect of publication bias was assessed using a funnel plot model and evaluated by Egger's test based on a linear regression. **Results:** The majority of research was conducted in Asia and comprised cross-sectional designs. Only one prospective study was identified. Twenty articles met the preset inclusion and exclusion criteria; 75% reported significant correlations of PIU with depression, 57% with anxiety, 100% with symptoms of ADHD, 60% with obsessive-compulsive symptoms, and 66% with hostility/aggression. No study reported associations between PIU and social phobia. The majority of studies reported a higher rate of PIU among males than females. The relative risks ranged from an OR of 1.02 to an OR of 11.66. The strongest correlations were observed between PIU and de-

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pression; the weakest was hostility/aggression. **Conclusions:** Depression and symptoms of ADHD appeared to have the most significant and consistent correlation with PIU. Associations were reported to be higher among males in all age groups. Limitations included heterogeneity in the definition and diagnosis of PIU. More studies with prospective designs in Western countries are critically needed.

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Introduction

Internet use has grown substantially over the past few decades, accounting for nearly 2 billion users globally [1]. Although studies indicate that the majority of Internet users are among adolescents and young adults [2–4], research shows that Internet usage is rising among older populations [5]. Given the broad spectrum of Internet users, it is important to understand the potential risks involved in compulsive use. Public health concerns are emerging concerning the propensity of compulsive Internet use developing into pathological behaviors.

The pathway from adaptive to pathological Internet use (PIU) appears to be ambiguous [6]; however, there are noteworthy characteristics distinguishing the two groups. Among adaptive users, the Internet appears to serve as a supportive tool, rather than a source of identity. There is evidence showing that adaptive use facilitates new and existing relationships through frequent and accessible online communication; it can promote socialization and self-esteem [7], as well as decrease loneliness [8]. Conversely, evidence has indicated that pathological Internet users tend to spend more hours online compared to adaptive users (e.g. online ≥ 10 –20 h/week) [9, 10] and are prone to use the Internet for specific online activities (e.g. compulsive gambling [11], pornography [12–14], extreme role-playing fantasies [15–17], and excessive gaming [18]). Research suggests that PIU may not only reflect a risk-behavioral syndrome, but also a clinical disorder, due to the presence of withdrawal and tolerance symptoms [19].

PIU is conceptually modeled as an impulse-control disorder that does not involve an intoxicant, and it shares qualities related to behavioral addiction [20]. Behavioral addiction, as suggested by Griffiths [21], is a paradigm that is based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria for pathological gambling and substance-dependence; it comprises six explicit traits: salience, mood modification, tolerance, withdrawal symptoms, conflict and relapse. It is hypothesized that the respective attributes of behavioral addic-

tion are present among pathological Internet users [22–24]. On this basis, PIU has been proposed for inclusion in the DSM-V as a behavioral addiction, but without success [25, 26]. Instead, PIU will be inserted in the DSM-V appendix, stipulating that more research is required before a diagnosis can be incorporated into the DSM nosological system [27]; this could potentially be a contributing factor to the lack of a universal diagnostic criteria for PIU, inevitably influencing outcomes of PIU-related studies.

The prevalence of PIU varies among populations. Epidemiological studies have reported considerable variations in the prevalence of PIU among adolescents and young adults, ranging from 0.9 to 37.9% [28–31] in Asia and 2 [27] to 18.3% [32–36] in Europe. In the US general population, PIU prevalence varies between 0.3 [37] and 8.1% [38]. It is evident that there are extreme variances in PIU prevalence across countries and cultures; further analysis on the psychological effect of prevalent PIU is necessary.

There may be severe mental and emotional implications for those with PIU; it should be noted that PIU may also occur as a consequence of ongoing mental health issues. Research has indicated a potential correlation between PIU and impulsivity [39, 40], depression [41, 42], anxiety [43], psychosis [44], obsessive-compulsive symptoms [45], and social anxiety/phobia [46]; however, data so far has been contradictory with regards to comorbid psychopathology. To the best of our knowledge, an evidence-based systematic review examining the association between PIU and psychopathological traits is still lacking [47]; scientific-based outcomes are required for preventive and treatment efforts.

The primary aim of this systematic review was to identify and evaluate studies performed on the correlation between PIU and comorbid psychopathology; secondary aims were to assess the diagnostic criteria for measuring PIU and outcome measures of psychopathology, map the geographical distribution of studies, and evaluate levels of evidence. Based on the available literature, the following psychopathologies were included: depression [48], anxiety [49], symptoms of attention deficit and hyperactivity disorder (ADHD) [50], obsessive-compulsive symptoms [51], social phobia [52], and hostility/aggression [53].

Methods

An electronic literature search was conducted using the following databases: MEDLINE, PsycARTICLES, PsycINFO, Global Health, and Web of Science. There were no restrictions on

language, time, or publication status. Key identifiers used were 'Internet addiction' or 'Internet addiction disorder' or 'Internet dependency' or 'pathological Internet use' or 'problematic Internet use' or 'compulsive Internet use' or 'excessive Internet use' or 'computer addiction', combined with the identifiers 'depression' or 'anxiety' or 'obsessive-compulsive' or 'ADHD' or 'social phobia' or 'hostility' or 'aggression'.

Articles were systematically and independently reviewed by the authors; assessments were performed regarding the study type, study population, methodology, outcome measures, effect sizes, and interpretation of results. The inclusion criteria for studies involved population-based studies with a large sample size (>200 subjects), ascertained diagnostic criteria for PIU, subsequent reporting on the correlation between PIU and predetermined psychopathologies, and the psychometric outcome measures assessing psychopathology. Studies were excluded if there were no clear diagnostic criteria, a significant sampling bias or small sample size (<200 subjects), only focused on specific subtypes of PIU (e.g. compulsive online gambling), and/or were case studies and/or treatment assessment.

Studies were rated according to the scheme proposed by the Oxford Centre for Evidence-Based Medicine Results [54] and evaluated by the following criteria: observation of a full or partial association, significance level, and adjustments for confounders. Full association was considered when a correlation was found for both sexes after multivariate analyses. If a correlation was identified for only one gender, it was classified as a partial association. The geographical distribution of studies was also mapped.

Effect size of the associations was identified by either the original publications or calculated using the data of the respective publications. Identified effect sizes were reported mostly in odds ratios (OR), with one publication reporting in hazard ratios (HR); the calculated effect sizes were either Cohen's d or R^2 . In order to compare the different associations, the effect sizes d and R^2 were stated as small, moderate, or large, according to Cohen [55]; OR were converted into these groups according to Chinn [56]. The effect sizes were interpreted accordingly: small ($d = 0.2$, $R^2 = 0.01$, $OR = 1.45$), moderate ($d = 0.5$, $R^2 = 0.06$, $OR = 2.50$), and large ($d = 0.8$, $R^2 = 0.14$, $OR = 4.25$).

The potential effect of publication bias was assessed for the relationship between PIU and depression. This effect could not be estimated for other psychopathologies, given that too few publications met the inclusion criteria. The publication bias was explored for depression by a funnel plot model. This graph was created by plotting the log OR against the standard error of these measures [57]. A funnel plot graph, shaped with a symmetrical distribution, would indicate no publication bias, whereas an asymmetric plot would suggest bias; this could be due to unreported studies, small sample sizes, or low significance levels [58]. The asymmetry of the funnel plot was statistically evaluated by Egger's test, which is based on a linear regression of the normalized effect estimate (estimate divided by its standard error) against precision (reciprocal of the standard error) [59]. If a publication bias was found, a trim and fill method [60] was used to estimate the number of missing studies and adjusted accordingly. This method is commonly used to remove the asymmetric side of the funnel plot by artificially imputing the missing studies, based on the other side of the graph.

Results

After deleting duplicate studies, a total of 185 articles were screened and identified through the present systematic search. As a result, 32 studies were immediately excluded, as they were based on other Internet-related topics. Twenty articles were included in the respective systematic review in accordance with the inclusion and exclusion criteria (fig. 1) [61].

Description of Included Studies

The included articles comprised one prospective cohort study (level of evidence: 1B) [62], two case-control studies (level of evidence: 3B) [63, 64], and 17 cross-sectional studies (level of evidence: 4) [65–81], as illustrated in table 1. Half of the studies ($n = 10$) in this review targeted adolescent groups, seven studies targeted young adults, and three studies were aimed at the general population; all studies examined both genders.

Geographical Distribution of Studies

Overall, the majority of studies performed on PIU were implemented in Asian countries. Eleven studies were performed in China [62, 64–68, 70, 73, 76, 77, 81] and five in South Korea [72, 74, 75, 79, 82]. The remaining studies were conducted in the US [71], UK [63], Norway [69], and Turkey [80].

Methods Assessing PIU

There are no standardized diagnostic criteria for identifying PIU; however, there are several assessment instruments that are often utilized in PIU research. The most common psychometric instrument(s) for measuring PIU is the Young's Diagnostic Questionnaire for Internet Addiction (YDQ) [83]. The YDQ is built upon the DSM-IV diagnostic criteria for pathological gambling and has been employed and validated in other studies [32, 35]. In the YDQ, the diagnosis is based on a pattern of Internet usage that results in a clinical impairment or distress in accordance to the presence of the following criteria: (1) preoccupation with the Internet; (2) need for longer amounts of time online to achieve satisfaction; (3) repeated unsuccessful efforts to control, cut back, or stop Internet use; (4) restlessness, moodiness, depression, or irritability when attempting to cut down or stop Internet use; (5) staying online longer than originally intended; (6) jeopardizing or risking the loss of a significant relationship, job, or educational opportunity because of the Internet; (7) lying to family members, therapists, or others to conceal the extent of involvement with the Internet;

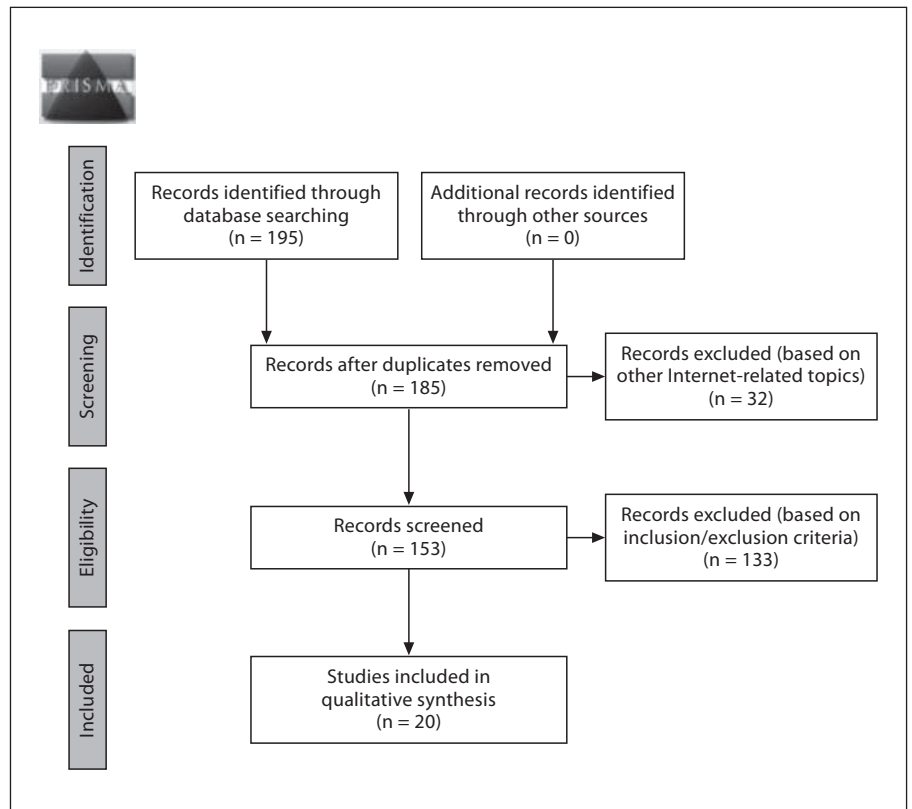


Fig. 1. PRISMA 2009 flow diagram [61].

and (8) using the Internet as a way of escaping from problems or relieving a dysphoric mood [20, 83]. The respective eight criteria are evaluated through eight 'yes' or 'no' questions with a total score ranging from 0–8. Those scoring ≥ 5 were classified as pathological. In the present review, two studies used the YDQ to measure PIU [64, 69]. Based on the YDQ, Young [84] further modified the assessment instrument to measure severity, thereby establishing a 20-item questionnaire that measures mild, moderate, and severe levels of PIU. Referred to as the Internet Addiction Test (IAT), the psychometric properties of this instrument have been evaluated and ascertained as valid and reliable [85]. The IAT was the most utilized assessment of PIU taxonomy in this review, with eight studies [63, 65, 68, 72, 74, 75, 78, 79] reporting to have used it. The second most frequently utilized instrument was the Chen Internet Addiction Scale [86], which was reported in seven studies [62, 66, 67, 70, 73, 77, 81] in this analysis. The Chen Internet Addiction Scale is a 26-item questionnaire, which has also been validated, and assesses five dimensions of the condition: compulsive use, withdrawal, tolerance, problems with interpersonal relationships, and time management [87]. The three residual

studies employed atypical measures: Internet Usage Questionnaire [71], Diagnostic Criteria of Internet Addiction [76], and Problematic Internet Use Scale [80].

Methods Assessing Psychopathology

Measurements of psychopathology in the scrutinized studies were performed by different psychometric mechanisms. To measure depression, five studies [62, 66, 71–73] used the Center for Epidemiologic Studies Depression Scale; two studies [63, 80] used Beck's Depression Inventory; and two studies [65, 68] used the Zung Self-Rating Depression Scale. One study employed the Diagnostic Interview Schedule for Children with Major Depression Disorder [74]; one study utilized the Mini-International Neuropsychological Interview [76]; one study used a modified Diagnostic Scale of Excessive Internet Use, which included an assessment of depression [79]; and one study used the 12-item version of the General Health Questionnaire [80]. To measure ADHD symptoms, five studies [62, 73, 76–78] used diverse versions of the Adult ADHD Self-Report Scale. To measure anxiety, one study used the Self-Rating Anxiety Scale [68], and one study used single-item questions [69] for both anxiety and ob-

Table 1. Study type, level of evidence, population and association including effect sizes between PIU and psychopathology

Source	Study type	Level	Population	Country	PIU measure	Outcome measure	Outcome variable	Association	Effect size
			n	sex					
Ko et al. 2009 [62]	cohort	1B	2,162 adolescents 12.36 ± 0.55	M/F	China	Chen Internet Addiction Scale	depression	none*,t	-
Morrison and Gore 2010 [63]	case-control	3B	1,319 general population 21.4 ± 0.11	M/F	UK	IAT	ADHD	full*	HR 1.72 (1.21-2.43)
							social phobia	none*,t	-
							hostility	full*	HR 1.67 (1.17-2.38)
						Beck Depression Inventory	depression	full*	d = 1.93
Xiuqin et al. 2010 [64]	case-control	3B	304 young adults 18 ± 2.7	M/F	China	YDQ	depression	full	d = 0.49
							anxiety	full	d = 0.18
							obsessive-compulsive	full	d = 0.18
							phobic anxiety	none	-
						hostility	full	d = 0.42	
Lam et al. 2009 [65]	cross-sectional	4	1,639 adolescents 13-18	M/F	China	IAT	depression	partial*,§	OR 3.7 (2.5-5.3)
Yen et al. 2009 [66]	cross-sectional	4	8,941 adolescents 14.7 ± 1.7	M/F	China	Chen Internet Addiction Scale	depression	full*	n/a
Ko et al. 2009 [67]	cross-sectional	4	9,405 adolescents ~15	M/F	China	Chen Internet Addiction Scale	aggression	full*	OR 1.30 (1.10-1.52)
Ni et al. 2009 [68]	cross-sectional	4	3,557 young adults 18.77 ± 1.14	M/F	China	Internet Addiction Test	depression	full*	d = 1.15
							anxiety	full*	d = 1.25
Bakken et al. 2009 [69]	cross-sectional	4	3,399 general population 16-74	M/F	Norway	YDQ	anxiety	full*	OR 11.24
							obsessive-compulsive	full*	OR 11.66
Yen et al. 2008 [70]	cross-sectional	4	3,517 adolescents 15.48 ± 1.65	M/F	China	Chen Internet Addiction Scale	depression	full*	OR 1.21 (1.01-1.46)
							anxiety	none [§] ,*,t	OR 0.79 (0.63-0.99)
							phobic anxiety	full*	OR 1.27 (1.05-1.53)
						Brief Symptoms Inventory	depression	full*	-
						hostility	full*	OR 1.47 (1.28-1.70)	d = 0.27
Fortson et al. 2007 [71]	cross-sectional	4	411 young adults 20.4 ± 3.2	M/F	USA	Internet Usage Questionnaire	depression	full	d = 0.27

Table 1 (continued)

Source	Study type	Level	Population		Country	PIU measure	Outcome measure	Outcome variable	Association	Effect size
			n	age ^a						
Ha et al. 2007 [72]	cross-sectional	4	452 adolescents	15.8 ± 0.41	M/F	South Korea	IAT	Center for Epidemiologic Studies Depression Scale	depression	full* R ² = 0.101
Yen et al. 2007 [73]	cross-sectional	4	1,890 adolescents	16.26 ± 0.99	M/F	China	Chen Internet Addiction Scale	Center for Epidemiologic Studies Depression Scale Attention-Deficit/Hyperactivity Disorder Self-Rated Scale Social Phobia Inventory The Chinese Hostility Inventory-Short Form	depression ADHD social phobia hostility	full* full* full* none* [§] partial* [§] OR 1.03 (1.02–1.05) OR 1.08 (1.06–1.10) – OR 1.02 (1.01–1.04)
Kim et al. 2006 [74]	cross-sectional	4	1,573 adolescents	15–16	M/F	South Korea	IAT	Diagnostic Interview Schedule for Children-Major Depression Disorder-Simple Questionnaire	depression	full d = 0.10
Jang et al. 2008 [75]	cross-sectional	4	851 adolescents	12–18	M/F	South Korea	IAT	Symptom Checklist 90-revision	depression	partial* [§] OR 1.15 (1.03–1.26)
Ko et al. 2008 [76]	cross-sectional	4	216 young adults	21.45 ± 2.05	M/F	China	Diagnostic Criteria of Internet Addiction	Mini-International Neuropsychological Interview Adult ADHD Self-Report Scale Mini-International Neuropsychological Interview	depression ADHD social phobia	partial* [§] OR 3.28 (1.22–8.84) full* OR 4.53 (1.49–5.31) none* [§] –
Yen et al. 2009 [77]	cross-sectional	4	2,619 young adults	20.46 ± 2.07	M/F	China	Chen Internet Addiction Scale	Adult ADHD Self-Report Scale	ADHD	full* OR 2.84 (2.09–3.87)
Yoo et al. 2004 [78]	cross-sectional	4	535 children	11.1 ± 1.0	M/F	South Korea	IAT	ADHD Self-Report Scale	ADHD	full* d = 0.76
Whang et al. 2003 [79]	cross-sectional	4	13,588 general population	26.74 ± 7.27	M/F	South Korea	Modified IAT	Modified Diagnostic Scale of Excessive Internet Use	depression	full d = 1.23
Ceyhan and Ceyhan 2008 [80]	cross-sectional	4	559 young adults	unspecified	M/F	Turkey	Problematic Internet Use Scale	Beck Depression Inventory	depression	full* R ² = 0.250
Cheung and Wong 2010 [81]	cross-sectional	4	719 adolescents	14.7 ± 2.02	M/F	China	Chen Internet Addiction Scale	General Health Questionnaire	depression	full* d = 0.49

^a Age is presented in years as a range or mean with SD. M/F = both males and females analyzed together. [§] Negative association. * Adjustment for controlling variables was performed. [§] Significant for males only. † A significant relationship was found in univariate analysis but it was not confirmed in a multivariate logistic model.

Table 2. Number of observed associations identified between PIU and psychopathology stratified by effect size

Effect size	Depression	Anxiety	Symptoms of ADHD	Obsessive-compulsive symptoms	Social phobia	Hostility/aggression
Small ^a	5	3	2	2	0	4
Moderate ^b	5	0	1	0	0	1
Large ^c	4	2	2	2	0	0
Total	14	5	5	4	0	5

^a $d = 0.2$, $R^2 = 0.01$, $OR = 1.45$. ^b $d = 0.5$, $R^2 = 0.06$, $OR = 2.50$. ^c $d = 0.8$, $R^2 = 1.14$, $OR = 4.25$.

sessive-compulsive symptoms. To measure obsessive-compulsive symptoms, one study used the Maudsley Obsessive Compulsive Inventory [72]. To measure hostility/aggression, one study used the Buss-Durkee Hostility Inventory [62], one study used the Chinese Hostility Inventory-Short Form [73], and one study used the Aggressive Behavior Questionnaire [67]. To measure social phobia, one study used the brief version of the Fear of Negative Evaluation Scale [62], and one study used the Social Phobia Inventory [73]. In two of the studies [64, 75], the Symptom Checklist 90-Revision [88] was used to assess multiple conditions, including depression, anxiety, phobic anxiety, obsessive-compulsive, and hostility. Another study used the Brief Symptoms Inventory [70] to measure the corresponding psychopathologies.

Association between PIU and Psychopathology

Significant correlations were reported between PIU and ADHD symptoms, depression, hostility/aggression, and obsessive-compulsive symptoms. Full associations were reported most frequently between PIU and symptoms of ADHD [62, 73, 76–78] (100% of examined studies) and depression [63, 66, 68, 70–74, 79–81] (75% of examined studies). A full association with obsessive-compulsive symptoms [64, 69, 72] and hostility/aggression [62, 64, 67, 70] was reported in 60 and 66% of examined studies, respectively.

Effect Size of Observed Associations

The relative risks of the associations between PIU and psychopathology ranged from an OR of 1.02 [73] to an OR of 11.66 [69]. The strongest correlations were observed between PIU and depression, whereas the weakest were identified between PIU and hostility/aggression. In total, the effect size of correlations comprised 10 large [63, 68,

69, 72, 76, 78–80], 7 moderate [64, 65, 76, 77, 81], and 16 small associations [62, 64, 67, 70, 71, 73–75] (table 2).

PIU and Age Groups

The studies included in the present review focused on three age groups as target populations: total population, young adults, and adolescents. Three studies examined the total population, which comprised diverse age groups, and the association between PIU and depression [63, 79], anxiety, and obsessive-compulsive symptoms [69]. In all three studies targeting the total population, a large effect size was found in the correlation between PIU and depression, anxiety, and obsessive-compulsive symptoms. Three of six studies targeting young adults identified an association, with a large effect size, between PIU and depression [68, 80], anxiety [68], and symptoms of ADHD [76]. The remaining 11 studies targeted adolescent populations. Of these 11 studies, two indicated a large effect size when assessing the correlation between PIU and depression, ADHD [78], and obsessive-compulsive symptoms [72]. In relation to the age-group distribution, large effect sizes were found in all studies targeting the total population, 50% targeting young adults, and 18% targeting adolescents.

PIU and Gender

Eleven studies [63, 65–67, 69, 70, 72, 75–78] found significantly higher rates of PIU among males compared to females. Three of the studies [68, 71, 74] found no significant gender differences. No study reported higher PIU rates among females.

PIU and Regions

In Asia, large effect sizes were observed in four studies [68, 76–78] concerning the association between PIU and depression, symptoms of ADHD, anxiety, and obsessive-compulsive symptoms. All European studies showed large effect sizes between PIU and correlated depression [63, 80], anxiety, and obsessive-compulsive symptoms [69]. The US study reported a small effect size between PIU and depression [71].

PIU and Depression

The majority of studies examined depression as an exposure variable. Concerning the overall correlation between PIU and depression, 12 studies found full associations, three studies found a partial association, and one study found no association. There were two case-control studies [63, 64] and 10 cross-sectional [66, 68, 70–74, 79–81] studies that found a full association between PIU and

depression. Among those, one case-control [64] and three cross-sectional [71, 74, 79] studies did not control for covariates. Moreover, after adjusting for confounders, three cross-sectional studies [65, 75, 76] found partial associations in male subjects only. However, in the only cohort study [62], after adjusting for covariates, there was no correlation found. Among the correlations detected, the effect sizes for the association with depression comprised four large [63, 68, 79, 80], five moderate [64, 65, 72, 76, 81], and five small [70, 71, 73–75] observed effects.

PIU and Anxiety

In the correlation between PIU and anxiety, four studies (one study on phobic anxiety) found a full association, whereas three studies (one study on phobic anxiety) found no association. The full associations identified comprised one case-control study [64], but did not control for confounding variables, and three cross-sectional studies [68–70]. Only one study found a negative correlation between PIU and anxiety in a univariate analysis; however, this was not statistically significant after controlling for confounding variables in a multivariate analysis [70]. Moreover, in the same study, though no association was found between PIU and anxiety, there was a significant association found with phobic anxiety, even after adjusting for confounders. However, in one of the case-control studies [64], there was no correlation found with phobic anxiety. Overall, correlations were identified for anxiety in three studies and phobic anxiety in one study, thereby resulting in four positive correlations for anxiety. The three residual studies found no association. The observed effect sizes in the association between PIU and anxiety were split between two large [68, 69] and two small [64, 70], with no study identified as moderate. Three studies included social phobia as an outcome variable in their analysis. These studies comprised one cohort [62] and two cross-sectional [73, 76] designs. After controlling for covariates, no correlation was found between PIU and social phobia.

PIU and Symptoms of ADHD

Five studies included symptoms of ADHD as an exposure variable; all five studies found full associations between PIU and ADHD. In all respective studies, correlations were confirmed after controlling for covariates. The studies comprised one cohort [62] and four cross-sectional designs [73, 76–78]. The effect sizes for the detected correlations between PIU and ADHD symptoms were also split between two large [76, 78] and two small [62, 73], with one reporting moderate [77] results.

PIU and Obsessive-Compulsive Symptoms

Five studies investigated the association between PIU and obsessive-compulsive symptoms. Three studies [64, 69, 72] reported full associations, one study [75] found a partial association for males only, and one study [70] found no association. Studies that found full associations comprised one case-control [64], which did not control for covariates, and two cross-sectional [69, 72] designs, which did control for covariates. The remaining two studies were both cross-sectional, and the results were reported after controlling for confounding factors. The effect sizes determined in the papers that reported associations between PIU and obsessive-compulsive symptoms were large in two cases [69, 72] and small [64, 75] in the other two.

PIU and Hostility/Aggression

Six studies examined the association between PIU and hostility/aggression. Among those, four studies [62, 64, 67, 70] found full association, one study [73] found a partial correlation for males only, and one study [75] found no correlation. The four studies that found full associations included one cohort [62], one case-control [64], and two cross-sectional designs [67, 70]. The remaining two studies both had a cross-sectional design. All but the case-control study adjusted for confounding factors. The weakest correlations were observed between PIU and hostility/aggression. The results illustrated one study with moderate [64] and four with small [62, 67, 70, 73] effect sizes.

Publication Bias

Analysis of the publication bias was only possible for studies reporting on PIU and depression, as there were a statistically insufficient number of studies reporting on the remaining psychopathologies in both the scientific literature and in the present review. Among the 16 studies reporting on PIU and depression, there were only six studies that reported OR; thus, the respective six studies on PIU and depression were included in the funnel plot model (fig. 2). The results illustrated that all six studies were asymmetrically located on the right side of the graph, indicating publication bias. The publication bias was statistically significant at the 5% risk level ($p = 0.022$). In order to adjust for this asymmetrical bias, the trim and fill method was implemented. This approach ascertained that an additional three studies reporting an OR were lacking on the other side of the funnel plot. A fill random effects meta-analysis using the six original studies and the three imputed missing studies were performed to cor-

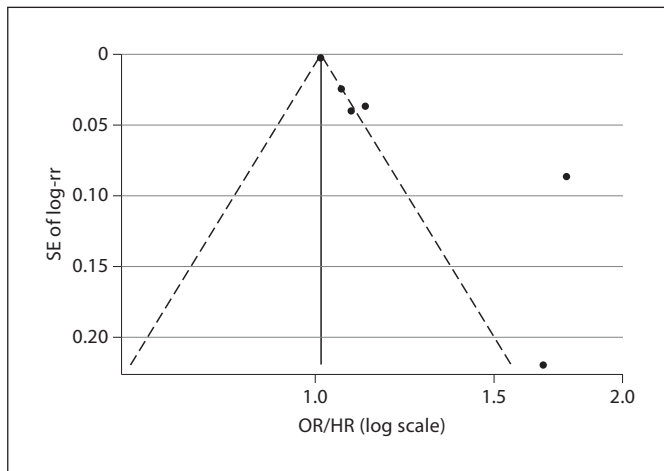


Fig. 2. Funnel plot with pseudo-95% confidence limits.

rect for the bias. The results of this meta-analysis suggest that the association between PIU and depression might occur due to publication bias. It must be underscored that these results should be interpreted cautiously, as research has noted at least 10 original studies are required in this model to obtain robust results [89, 90].

Discussion

In the present systematic review on PIU and psychopathology, 75% of the studies reported significant associations with depression, 57% with anxiety, 100% with symptoms of ADHD, 60% with obsessive-compulsive symptoms, and 66% with hostility/aggression. No study reported associations between PIU and social phobia. In general, the strongest association was found between PIU and depression; however, a preliminary analysis of a potential publication bias necessitates caution in its interpretation. Notwithstanding, it should be noted that, in general, only a marginally small number of publications were reported on PIU in the literature. On this basis, it is uncertain if the association found between PIU and psychopathologies occurred on the basis of an actual significant relationship or the result of publication bias. This will have to be assessed once there are more epidemiological data reported in the field of Internet behavioral addictions.

In all analyses, the effect sizes examined indicated that the strongest association was found between PIU and depression, whereas the weakest correlation was between

PIU and hostility/aggression. Large effects were observed in studies performed in Europe and studies that targeted all age groups. Based on these results, it is plausible that subjects with PIU are at higher risk for comorbid psychopathology. On the other hand, it is also possible that psychopathology leads to PIU. Longitudinal data is required to assess the causal interaction; however, only one study included a prospective cohort design, and only two studies used a case-control design. The remaining 17 studies employed a cross-sectional design. Although the cross-sectional design is reliable in determining associations, it is unable to report on the causal relationship between PIU and specific psychopathologies. We have clear information concerning the association between PIU and psychopathology, but scarce data on causality. It is recommended that more prospective cohort studies be performed within this scientific field.

The strong association between PIU and symptoms of ADHD reported in the literature is not surprising. Persons with ADHD are easily bored and thrive for instant gratification. Given the widespread availability of the Internet, individuals have access to a constant stream of information and may engage in more activities at the same time. Moreover, ADHD individuals often lack self-control, which can, in turn, sustain an addiction to the Internet. Evidence also indicates that persons with ADHD suffer from learning disabilities [91] and dyslexia [92], social [93] and emotional impairments [94], extreme aggression, and externalizing symptoms [95]. There is also a high level of stigmatization associated with ADHD [96]. These could be contributing factors influencing the association between PIU and ADHD symptoms. Longitudinal analyses, which adjust for these confounding factors, are critically needed.

Remarkably, not one study found a correlation between PIU and social phobia. These results were unexpected, as it is theorized that subjects with social phobia suffer from isolation, and thus spend longer time online, which increases the propensity for dependency [62]. Another interesting finding is that only half of the studies found an association between PIU and anxiety. The link to anxiety was postulated to be a strong indicator of PIU [97, 98]; however, this was not found in the present systematic review. There are several factors that may influence this result. Outcome measures in assessing anxiety were not equally standardized as observed in depression and symptoms of ADHD. Moreover, as often characterized in behavioral addiction disorders, dependency can serve as a coping mechanism to relieve stress and anxiety. There is also the possibility that Internet illiteracy causes

anxiety in some users. Research indicates that the capability to navigate the Internet is linked with the level of anxiety, i.e. less Internet competence results in higher anxiety levels [99]. Internet literacy often depends on the population; adolescents tend to be more e-literate than older age groups [100], indicating higher anxiety levels among adult Internet users. Age group, gender, and geographic region all played significant roles in the relationship between PIU and anxiety.

The geographical distribution of research in this field does not appear to be homogeneous. Eighty percent of the studies depicted in this review were performed in Asia, with the majority being in China alone. The communication and technology sectors are increasing rapidly in China; statistics show that China has the highest number of Internet users worldwide. Moreover, the population of China is higher than the European Union. There are also distinctive cultural variances, such as history, religion, traditions, customs, education, and ethnic groups that affect Internet users differently. These cultural variations could potentially be involved in the intricate relationship between PIU and comorbid psychopathology. It is evident, given cultural disparities, that the results cannot automatically be interpreted in the context of other cultures and continents. Thus, more research needs to be performed in other regions of the world for eventual cross-cultural comparisons.

One of the major issues in research on PIU is the lack of a universal diagnostic criterion for assessing Internet-related pathological behaviors. This review illustrated a wide range of diagnostic tests were used in different studies. The most common assessment instrument for measuring PIU was the IAT, followed by the Chen Internet Addiction Scale. The IAT accounts for severity of PIU, which is essential in grouping different levels of Internet users. However, these scales have limitations, e.g. they do not account for the content of preferred online activities of the Internet user. Instead, all Internet-related behaviors are pooled together, such as gambling, consumption of pornographic materials, social networking, gaming, and/or reading online news. A deeper understanding of the productive and destructive influences of Internet activities would be helpful in shedding light on the distinct mechanisms of Internet pathology, as well as distinguishing PIU from other addictions.

Limitations

Although there were no language restrictions in the database search, there is a potential risk that some non-English publications were missed. However, studies in

other languages, with an abstract in English, were also included in the search. The analysis did not address mediating factors that may arbitrate the link between PIU and psychopathology, e.g. drug and alcohol abuse. There is heterogeneity in the definition and diagnosis of PIU, as well as psychometric instruments used to measure psychopathology; this could potentially limit cross-national comparisons. Additionally, most studies so far are lacking detailed assessment of online-activities, despite the fact that they are likely to play an important role in the association between PIU and comorbid mental health issues. Publication bias could only be partly assessed in PIU and depression, due to the insufficient number of publications in this research field.

Conclusions

The present systematic review identified scientific studies indicating strong associations between PIU, symptoms of ADHD, and depression. Anxiety, social phobia, obsessive-compulsive symptoms, and aggression did not appear to be significant factors of PIU. Given that the majority of studies were of cross-sectional design, causal relationships could not be identified. Publication bias should also be considered when interpreting these results. Prospective cohort studies, in this area of research, are necessitated in order to detect the causal liaison between these respective variables.

It is recommended for further research to focus on larger epidemiological studies that use standardized methodologies, which can be utilized in subsequent systematic reviews. In-depth investigations that focus on the distinctive content of online activities in relation to PIU are critically needed. The information derived from such an analysis would prove essential in better understanding the idiosyncratic pathways of PIU and comorbid psychopathology.

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