ORIGINAL ARTICLE

The Effect of Psychosocial Interventions for Reducing Co-occurring Symptoms of Depression and Anxiety in Individuals with Problematic Internet Use: A Systematic Review and Meta-analysis

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Abstract

The objective of this study is to conduct a systematic review and meta-analysis to assess the effect of psychosocial interventions in reducing problematic Internet use (PIU), anxiety, and depression symptoms in a sample of people. This review was registered on the PROSPERO database (CRD42020181912) and a total of 15 studies were included. Analyses of the effect of the interventions were conducted based on the standardized mean difference of the studied outcomes (PIU, anxiety, and depression). Most studies reported a positive effect of psychosocial interventions on reducing symptoms of PIU, depression, and anxiety among people with PIU. However, only one detected a robust effect in reducing symptoms of anxiety. For depression, this effect was more modest, and there was no difference between the different modalities of psychosocial interventions. The results suggest that psychosocial interventions are effective in reducing both symptoms of PIU and co-occurring symptoms of depression and anxiety in individuals with PIU.

Keywords Problematic Internet use · Depression · Anxiety · Interventions

Access to the Internet has proliferated substantially, with 5 billion people accessing the Internet daily (IWS, 2021). People are also spending more time on the Internet, and individuals are currently connected on average of 6 h and 40 min a day (InterNations, 2019). Many authors have reported that excessive Internet use has increased in many countries (Andrade et al., 2021a; Duong et al., 2020; Spritzer et al., 2022; Yang et al., 2018), particularly among younger people (Derevensky et al., 2019; Lin et al., 2018). The increase in excessive Internet use may be due to several factors, including greater ease of access, new forms of entertainment (social media), and devices with advanced technological resources (Geyer et al., 2021).

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Currently, the term "problematic internet use" (PIU) has been used to describe behaviors related to lack of control, craving, and emotional instability caused by the lack of access to the Internet (Andrade et al., 2020b; Gómez et al., 2017). For this reason, PIU shares clinical similarities to substance and behavioral addictions, such as gambling, video game addiction, and sex addiction (Duong et al., 2020; Gómez et al., 2017). For instance, neuroimaging studies have shown that individuals with PIU exhibit activation of neural areas compared with substance use disorders (Chun et al., 2018) and behavioral addictions (Darnai et al., 2019).

As with other potentially addictive behaviors, there is no single factor that accounts for PIU. The theoretical Interaction of Person-Affect-Cognition-Execution (I-PACE) model proposed by Mathias Brand and colleagues was designed to explain the multi-faceted nature of the development and maintenance of behaviors related to PIU (Brand et al., 2016). The I-PACE considers the environmental aspects, individual characteristics, affect, and cognition associated with PIU. Regarding the affective component, studies indicate that individuals with PIU have lower quality of life (Andrade et al., 2021b) and a higher frequency of emotional problems (Cruz et al., 2018).

Importantly for the present study, there is evidence that symptoms of depression and anxiety are the disorders commonly associated with PIU (Li et al., 2017a, 2017b; Malak & Khalifeh, 2018). In a study conducted with over 15,000 Brazilian Internet users, those with PIU were 10×more likely to have major depressive symptoms and 7×more likely to have anxiety symptoms than individuals with no PIU (Andrade et al., 2020a). During the COVID-19 outbreak, some authors have found that symptoms of anxiety and depression have increased among individuals with PIU (Awan et al., 2021; Li et al., 2021). The association between PIU, anxiety, and depression have also been supported by mediation models between reinforcing stimuli and PIU (Casale et al., 2016; Wang et al., 2018) and in longitudinal approach that suggests certain psychopathologies may aggravate PIU symptoms over time (Dahl & Bergmark, 2020).

One of the links between emotional problems and PIU may be related to searching online for new relationships and virtual friendships. In this sense, the Internet is being used as an emotion regulation strategy (Faghani et al., 2020). These strategies are related to the cognition component in the I-PACE model in which cognitive skills are important to maintain or decrease the intensity of symptoms of PIU. In a study conducted by Spada and Marino (2017), emotion regulation was positively correlated with PIU. Together, these findings indicate that psychosocial interventions focused on regulating one or more of these components may be potentially effective in reducing PIU-related behaviors and the emotional problems associated with its use.

One of the first published intervention studies for people with PIU used Cognitive Behavioral Therapy (CBT) with a 12-session protocol (Young, 2011) that was later replicated with promising results (Young, 2013). In addition to CBT, other models, such as ecological (Stieger and Lewetz, 2018), positive psychology (Khazaei et al., 2017), and mindfulness (Quinones & Griffiths, 2019) have been used as a potential treatment for PIU with positive results. Although previous systematic reviews have assessed the effects of these interventions on PIU, few studies have reviewed whether these interventions also influence other components of the I-PACE model (Brand et al., 2019) that could be involved with the development and maintenance of PIU. A broader review of the effects of these interventions on additional components linked to the maintenance of the PIU may clarify the effectiveness of psychosocial interventions for PIU.

The present study aimed to conduct a systematic review and meta-analysis to examine the effect of different psychosocial interventions on PIU, depression, and anxiety symptoms

in individuals with PIU. We hypothesized that (i) the psychosocial interventions would be effective both in reducing PIU-related symptoms and (ii) among studies that evaluated secondary measures, these interventions would also improve symptoms related to depression and anxiety.

Method

The protocol for this study was pre-registered on the International Prospective Register of Systematic Reviews platform (PROSPERO; no. CRD42020181912). This study was conducted in the following steps: (i) identification of research question; (ii) definition of inclusion and exclusion criteria; (iii) literature search; (iv) selection of studies; (v) data extraction; and (vi) assessment of publication bias and quality of studies.

Identification of the Research Question

The FINER criteria (Hulley et al., 2007) were used to assess whether the research question (Are psychological interventions for PIU also effective in reducing depression and anxiety?) was *f*easible, *i*nteresting, *n*ovel, *e*thical, and *r*elevant. The research question indicated that it is feasible to be answered as this is a current topic, and there is a growing scope of literature that recognizes the importance of future research to assess treatments for people with PIU and their co-occurring mental health disorders.

Definition of Inclusion and Exclusion Criteria

We used the PICOS strategy to define the characteristics of the sample and the profile of the studies to be included (da Costa Santos et al., 2007). Individuals of all ages from empirical studies that presented the following methodological characteristics were included: (i) experimental or quasi-experimental studies; (ii) PIU was assessed using an instrument that was previously validated in the study country; (iii) studies also assessed anxiety and depression by means of previously validated instrument or clinical interview with a specialist in mental health (psychiatrist or psychologist); (iv) an independent follow-up assessment was conducted upon completion of the intervention; and (v) the studies included a protocol describing the intervention. We included only studies published in English, Portuguese, or Spanish.

We excluded studies that evaluated PIU associated with video game disorder, social media use, or substance use because some authors have shown that PIU can be confused with other behaviors with similar clinical characteristics (Shapira et al., 2003). As PIU is not considered a specific mental disorder, it may have clinical and behavioral characteristics confounding with behavioral addictions (Derevensky et al., 2019). Literature review studies, intervention protocols, and interventions focusing on the prevention of Internet use were also excluded. For more details, see Supplementary Table 1.

Literature Search

Six databases (CINAHL, LILACS, PsycArticles, PubMed, Scopus, and Web of Science) were searched on August 2020 and updated in November 2021. For the search strategy,

the descriptors used were previously consulted in the Medical Subject Headings [MeSH] and/or [DeCS] thesaurus and combined using Boolean operators that formed specific algorithms for each database (Table 1). The presence of descriptors in any field of the manuscript (title, abstract, or full text) were considered for screening to maximize the retrieval of relevant articles. All articles found were exported to Rayyan software (Ouzzani et al., 2016).

Selection of Studies

The screening and removal of duplicate records were conducted by two independent reviewers using Rayyan software (see Fig. 1 for a PRISMA diagram). After duplicates were removed, 1676 articles were assessed based on their title and abstract. Thirty-two studies were then included for full-text review. Three reviewers carefully read the complete text and 17 articles were removed at this stage. This process occurred blindly, using Rayyan software (Blind on), in which none of the reviewers had access to information from the others until the conclusion of the analyses. In total, 15 met the inclusion criteria and were included for synthesis and meta-analysis. Supplementary Table 1 shows the exclusion criteria for 17 studies according to each reviewer. We include this data for ethics and transparency of our protocol.

Data Extraction

Data were imported from.RIS files for each of the databases to the Rayyan software, except for the CINAHL database, which was imported to Mendeley due to the incompatibility with Rayyan. Next, we used the Airtable Platform to extract and organize the following data: (i) publication details (author, year, country, sample profile, and age); (ii) measures used to assess PIU (instruments, interviews, and others); (iii) methodological design; (iv) conflict of interest; and (v) main results.

Assessment of Publication Bias and Quality of Studies

We used the ROBIS tool to assess the risk of bias in the systematic review (Whiting et al., 2016). This method comprises three steps: (i) assessing the relevance; (ii) identifying concerns about the review process; and (ii) judging the risk of bias which was defined as follows, whether the methods used in our systematic review minimized the risk of bias of the summary estimates and conclusions of the evaluated studies. Particularly in the second step, four dimensions assessed the risk of bias: (i) study eligibility criteria; (ii) identification and selection of studies; (iii) data collection and study appraisal; and (iv) synthesis and findings (see Supplementary Table 1).

Analyses

The analyses were conducted using the standardized mean difference as the outcome measure for all variables (PIU, anxiety, and depression). A random-effects model was fitted, and we estimated the amount of heterogeneity based on the maximum-likelihood estimator. Also, we used standardized residuals and Cook's distances to detect whether interventions may be outliers and/or were influential in the context of the model. We considered as

Table 1 Search strategy based on algorithms tailored to each database

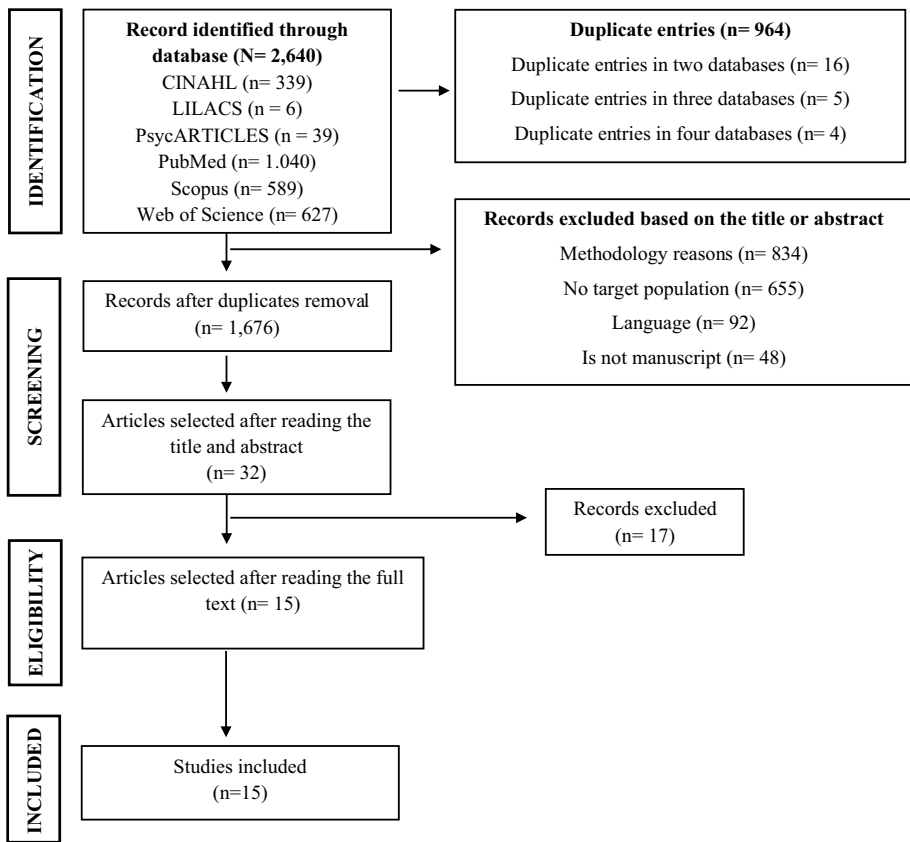| Database	Algorithm	N
CINAHL	("internet addiction" OR "problematic internet use" OR "dysfunctional internet use") AND (treatment OR intervention OR therapy OR psychotherapy)	339
LILACS	("internet addiction" OR "problematic internet use" OR "dysfunctional internet use") AND (treatment OR intervention OR therapy OR psychotherapy)	6
PsycArticles	("internet addiction" OR "problematic internet use" OR "dysfunctional internet use") AND (treatment OR intervention OR therapy OR psychotherapy)	39
PubMed	("internet addiction"[All Fields] OR "problematic internet use"[All Fields] OR (dysfunctional[All Fields] AND ("internet"[MeSH Terms] OR "internet"[All Fields])) AND (("therapy"[Subheading] OR "therapy"[All Fields] OR "treatment"[All Fields] OR "therapeutics"[MeSH Terms] OR "therapeutics"[All Fields]) OR ("methods"[MeSH Terms] OR "methods"[All Fields] OR "therapy"[All Fields] OR "therapeutics"[MeSH Terms] OR "therapeutics"[All Fields]) OR ("intervention"[All Fields] OR ("therapy"[Subheading] OR "therapy"[All Fields] OR "therapeutics"[MeSH Terms] OR "therapeutics"[All Fields]) OR ("psychotherapy"[MeSH Terms] OR "psychotherapy"[All Fields]))	1040
Scopus	TITLE-ABS-KEY (("internet addiction" OR" problematic internet use" OR" dysfunctional internet use") AND (treatment OR intervention OR therapy OR psychotherapy)) AND (LIMIT-TO (DOCTYPE," ar")) AND (LIMIT TO (LANGUAGE," English") OR LIMIT-TO (LANGUAGE, "Portuguese")) OR LIMIT-TO (LANGUAGE, "Spanish"))	589
Web of Science	(("internet addiction" OR "problematic internet use" OR "dysfunctional internet use") AND (treatment OR intervention OR therapy OR psychotherapy))	627
Total		**2640**

Fig. 1 Flow diagram of search

outliers those data with a Cook's distance of three times greater than the mean. Finally, the funnel plot asymmetry was checked based on the rank correlation and regression test.

Results and Discussion

Regarding the description of the studies included (Table 2), a third of the studies ($n = 5$) were conducted with Chinese individuals, and more than half of the studies included Asian people ($n = 8$). These data are relevant because many authors have reported a high prevalence of PIU in Asian countries (Li et al., 2021). In some of these countries, the use of smartphones is encouraged by authorities to perform daily activities (paying bills, shopping, transport tickets) (Li, 2019), which may increase the risk of PIU.

Although some authors have reported a higher prevalence of PIU among younger individuals (Andrade et al., 2021c; Derevensky et al., 2019), we identified only five studies evaluating the effect of psychosocial interventions exclusively in adolescents with PIU (studies 1, 2, 3, 5, and 8 in Table 2). The remaining studies were conducted in populations with vast age ranges (between 13 and 65 years). There is a large amount of evidence that adolescents present not only a higher prevalence of PIU compared to adults but also

Table 2 Main methodological and intervention characteristics of each study

No	Authors	Year	Country	Age	Method	Arms (n)	Measures	Intervention	No and length of sessions	Profile
1	Du et al	2010	China	12–17	Es	CG=24 EG=32	BDQIA, IOS-S, TMDS, SDQ, SCARED	EG=CBT	CBT=8 (90–120 min)	G
2	Gholamian et al	2019	Iran	16–17	QeS	CG=60 EG=60	BASNEF, NSKQ, YDQ	EG=BASNEF	BASNEF=2 (NA)	G
3	Hui et al	2017	China	19–25	RCT	CG=37 EG₁=39 EG₂=36	YDQ, SCL-90, P50	EG₁=EA EG2=CT EG3=EA+CT	EA=10 (30 min) CBT=5 (30 min)	G+I
4	Ke et al. (a)	2018	Malaysia	13–18	QeS	EG=4 5	PIUQ, DASS-42, SIAS	EG=CBT	CBT=8 (90 min)	G
5	Ke et al. (b)	2018	Malaysia	13–18	QeS	EG=157	PIUQ, DASS -42, SIAS	EG=CBT	CBT=8 (90 min)	G
6	Khazaei et al	2017	Iran	20–30	RCT	CG=24 EG=24	YDQ, Y-BOCS, QRI, SI	EG=PP	PP=10 (NA)	G
7	Kim et al	2018	South Korea	12–17	QeS	EG=17	K-scale, YDQ, IAS, CDI, STAI	EG=CBT	CBT=8 (120 min)	G
8	Pan	2020	China	13–18	QeS	CG=10 EG₁=10 EG₂=10 EG₃=10	YDQ	EG₁=CBT EG₂=PE EG₃=CBT+PE	NA	G+I
9	Quinones et al	2019	UK	39–42	RCT	CG=148 EG₁=343 EG₂=151	CIU, FFMQ, PHQ-ADS	EG₁=MDF EG₂=GR	Using app=14 (10 min)	I
10	Santos et al	2017	Brazil	18–65	QeS	EG₁=42 EG₂=42	IAT, HAM-A, HDRS, CGI	EG₁=PPE EG₂=CBT+pharmacotherapy	CBT=8–10 (NA)	G+I
11	Tas et al	2018	Turkey	15	QeS	CG=12 EG=12	YDQ, SCL-90	EG=PPE	PPE=10 (50 min)	G
12	Thorens et al	2014	Swiss	13–67	QeS	EG=57	ACP, IAT	EG=CBT	CBT=6 (50 min)	Individual
13	Yang et al	2017	China	18–30	RCT	EG₁=15 EG₂=14	IAS, BIS-11, MRS	EG₁=EA EG₂=PP	EA=45 (30 min) PP=11 (120 min)	G+I
14	Young	2013	EUA	22–56	QeS	EG=128	COQ, IAT	EG=CBT	CBT=12 (NA)	-

Table 2 (continued)

No	Authors	Year	Country	Age	Method	Arms (n)	Measures	Intervention	No and length of sessions	Profile
15	Zhu et al	2012	China	19–25	RCT	$EG_1=39$ $EG_2=36$ $EG_3=37$	IAT, WMS	$EG_1=EA$ $EG_2=CT$ $EG_3=EA+CT$	EA = 10 (30 min) CBT = 5 (30 min)	G+I

Legend: *Es*, experimental study; *QeS*, quasi-experimental study; *CG*, control group; *EG*, experimental groups; *CBT*, cognitive-behavioral therapy; *PP*, positive psychology; *G*, group therapy; *I*, individual therapy; *EA*, electroacupuncture; *CT*, comprehensive therapy; *PPE*, psychoeducational program; *PE*, physical exercise; *APP*, applicative; *MDF*, mindfulness; *GR*, gradual relaxation; *BASNEF*, Belief, Attitude, Subjective Norm, and Enabling Factors; *NA*, not available; *BDQIA*, Beard's Diagnostic Questionnaire for Internet addiction; *IOS-S*, Internet Overuse Self-Rating Scale; *TMDS*, Time Management Disposition Scale; *SDQ*, Strength and Difficulties Questionnaire; *SCARED*, Screen for Child Anxiety Related Emotional Disorders; *BASNEF*, Belief, Attitude, Subjective Norm, and Enabling Factors; *NSKQ*, Knowledge Questionnaire; *YDQ*, Young's Diagnostic Questionnaire; *SCL-90*, Brief Symptom Inventory; *PIUQ*, Problematic Internet Use Questionnaire; *DASS*, Depression, Anxiety, Stress Scales; *SIAS*, Social Interaction Anxiety Scale; *Y-BOCS*, Yale–Brown Obsessive Compulsive Scale; *QRI*, Quality of Relationships *nventory*); *SI*, severity of Internet use; *K-scale*, Korean Internet addiction self-report test; *IAS*, Young's Internet Addiction Scale; *CDI*, Children's Depression Inventory; *STAI*, State-Trait Anxiety Inventory; *CIU*, Compulsive Internet use; *FFMQ*, Five Facet Mindfulness Questionnaire; *PHQ-ADS*, Patient Health Questionnaire Anxiety and Depression Scale; *IAT* Internet addiction test; *HAM-A*, Hamilton Anxiety Scale; *HDRS*, Hamilton Depression Scale; *CGI*, Clinical Global Impressions; *SCL-90*, Brief Symptom Inventory; *ACP*, *Avaliação clínica psiquiatrica*; *BIS-11*, Barratt Impulsiveness Scale; *MRS*, Magnetic Resonance System; *COQ*, client outcome questionnaire); *WMS*, Wechsler Memory Scale

a higher frequency of comorbidities (Andrade et al., 2020c; Cruz et al., 2018; Dahl & Bergmark, 2020; Gómez et al., 2017), which tends to be more intense in adults (Pan et al., 2020).

Therefore, further studies are needed to investigate interventions that may be effective in reducing PIU, depression, and anxiety symptoms among adolescents with PIU. The main results are synthesized in Table 3. In all the evaluated studies, positive effects were reported in reducing the intensity of PIU and emotional problems regardless of the treatment modality. However, a meta-analysis was conducted to assess each study's weight in reducing PIU symptoms and emotional problems. Considering the type of intervention, most studies ($n=9$) used cognitive-behavioral therapy (CBT) as the main therapeutic method, followed by positive psychology (PP; $n=2$), and electro-acupuncture (EA; $n=2$).

Effects on Symptoms of PIU

A total of 20 interventions derived from the 15 studies were included to assess the effect on PIU symptoms, as shown in Fig. 2. The observed standardized mean differences ranged from -0.92 to 4.72, with the majority (70%) of positive estimates and the rest of them the true outcome may be negative. The standardized residuals indicated that none of the studies had a value larger than ±3.02; and there was no indication of outliers. None of the studies were identified as being overly influential when evaluating the values of Cook's distance. Neither the rank correlation nor the regression test indicated any funnel plot asymmetry ($p=0.12$ and $p=0.12$, respectively). The data indicated that none of the tested interventions (alone or in conjunction with any other) had a greater influence on reducing PIU symptoms. These findings are in accordance with previous studies in the literature (Saletti et al., 2021; Winkler et al., 2013). On the other hand, these same authors could not identify a robust effect of interventions in reducing PIU symptoms.

One unexpected finding was that CBT did not stand out as an intervention that significantly influenced the reduction of PIU symptoms. Reviews of randomized controlled trials have shown a positive effect of CBT in treating problems related to impulse disorders, but the effect size was generally modest (Campbell et al., 2018; Carroll & Kiluk, 2017; Perry & Lawrence, 2017). Therefore, in clinical practice for people with addiction symptoms, even the best available research evidence still has limited success rates, which shows the complexity and multifactorial factors involved in these behaviors (Carroll & Kiluk, 2017; Lopes et al., 2021).

Considering the similarities of PIU with addictive behaviors and impulse-control disorders, the interventions and recommendations discussed above tend to present good responses in the treatment of PIU as seen in the meta-analysis conducted in this study. Spada (2014) warned of the relevance of assessment tools and interventions aimed at controlling one's use of the Internet since this behavior leads to negative consequences in daily life.

Effects on Symptoms of Anxiety

Figure 3 shows the effect of 12 interventions derived from the 8 studies in reducing anxiety symptoms. The observed standardized mean differences ranged from 0.0 to 3.69, and we mainly found positive estimates (75%). Only one intervention (CBT + pharmacotherapy) had standardized residuals larger than ±2.86 and could be overly influential (Santos et al., 2017).
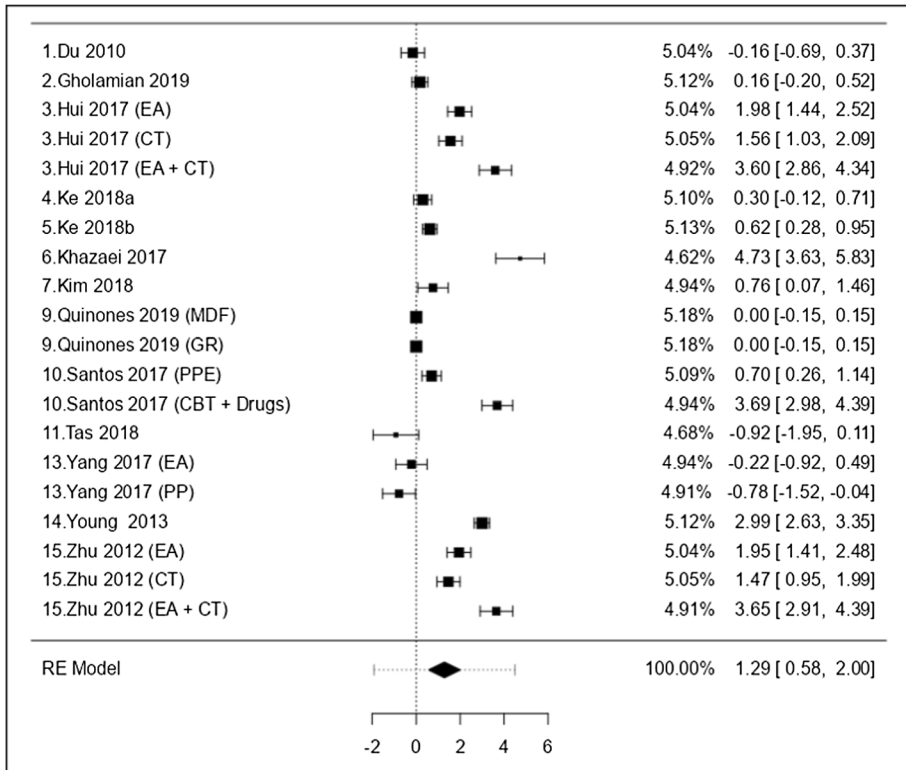
Table 3 Main results found in the assessed studies

| N	Authors	Main results
1	Du et al	**CBT** reduced **PIU** scores in adolescents, mainly in self-time management compared to **CG**. The intervention also significantly reduced Internet usage time, improved emotional management and cognitive bias, and reduced internet-related behavior
2	Gholamian et al	**BASNEF** significantly reduced Internet usage time compared to **CG**. The intervention also significantly increased the scores for the variables: knowledge; attitude; subjective norms; perceived behavioral control; facilitating factors for Internet use
3	Hui et al	The group that received the combined intervention (**CBT + EA**) had significantly lower **PIU** scores and lower levels of anxiety and depression compared to the other groups. The combined intervention also increased the amplitude and latency of P50 of Auditory Evoked Potential in subjects with **PIU**
4	Ke et al. A	**CBT** prevented a more damaging progression of **PIU** and reduced participants' anxiety, stress, and phobic interaction. These results were maintained 1 month after the study (follow-up)
5	Ke et al. B	**CBT** significantly reduced the intensity of Internet usage time; **PIU** score and social anxiety. Most participants were able to manage their Internet usage time better and increase social interaction. These results were maintained 1 month after the study (follow-up)
6	Khazaei et al	**PP** reduced Internet severity rates and the number of individuals with **PIU** compared to CG. The authors also reported that **PP** promoted an improvement in the quality of social relationships
7	Kim et al	**CBT** reduced **PIU**, anxiety and depression scores in adolescents compared to **CG**. After 1 month, the **PIU** scores were lower than baseline, but the intensity of anxiety and depression symptoms was even lower immediately after the program
8	Pan	The combined intervention (**CBT + PE**) significantly reduced **the other groups' PIU symptoms (time and motivation to use the Internet)**
9	Quinones et al	The **MDF** and **GR** interventions were equally effective in reducing symptoms of anxiety and depression, and the **MDF** had a significantly greater effect in reducing **PIU**
10	Santos et al	**CBT** combined with medication significantly reduced **PIU** and anxiety compared to **PPE** group participants
11	Tas et al	**PPE** significantly reduced **PIU,** and psychological symptoms compared to CG. It was effective in reducing psychological symptoms and Internet addiction. These results were maintained 45 days after the end of the study (follow-up)
12	Thorens et al	Participants undergoing **CBT** significantly improved their **PIU** symptoms and **CGI** score concerning themselves before the intervention
13	Yang et al	Both **EA** and **PP** reduced **PIU** scores, and **EA** more intensely reduced scores related to **PIU** subfactors (behavioral control, impulsivity control, and protection of brain neurons)

Table 3 (continued)

N	Authors	Main results
14	Young	**CBT** significantly reduced **PIU** scores from baseline. In addition, more than 95% of participants improved the way they manage **PIU**-related symptoms. Almost 80% of these participants remained recovered 6 months after the study (follow-up)
15	Zhu et al	In the three groups (**EA**; **CT**; **EA + CT**), a reduction in **PIU** scores and an increase in short-term memory capacity was detected. In the **CT** group, the **PIU** scores were even lower compared to the other groups

Legend: *CBT*, cognitive-behavioral therapy; *PIU*, problematic Internet use); *CG*, control group; *BASNEF*, Belief, Attitude, Subjective Norm, and Enabling Factors); *EA*, electroacupuncture; *PP*, positive psychology; *PE*, physical exercise; *MDF*, mindfulness; *GR*, gradual relaxation; *PPE*, psychoeducational program; *CGI*, Clinical Global Impressions; *CT*, comprehensive therapy

1.Du 2010		5.04%	-0.16 [-0.69, 0.37]
2.Gholamian 2019		5.12%	0.16 [-0.20, 0.52]
3.Hui 2017 (EA)		5.04%	1.98 [1.44, 2.52]
3.Hui 2017 (CT)		5.05%	1.56 [1.03, 2.09]
3.Hui 2017 (EA + CT)		4.92%	3.60 [2.86, 4.34]
4.Ke 2018a		5.10%	0.30 [-0.12, 0.71]
5.Ke 2018b		5.13%	0.62 [0.28, 0.95]
6.Khazaei 2017		4.62%	4.73 [3.63, 5.83]
7.Kim 2018		4.94%	0.76 [0.07, 1.46]
9.Quinones 2019 (MDF)		5.18%	0.00 [-0.15, 0.15]
9.Quinones 2019 (GR)		5.18%	0.00 [-0.15, 0.15]
10.Santos 2017 (PPE)		5.09%	0.70 [0.26, 1.14]
10.Santos 2017 (CBT + Drugs)		4.94%	3.69 [2.98, 4.39]
11.Tas 2018		4.68%	-0.92 [-1.95, 0.11]
13.Yang 2017 (EA)		4.94%	-0.22 [-0.92, 0.49]
13.Yang 2017 (PP)		4.91%	-0.78 [-1.52, -0.04]
14.Young 2013		5.12%	2.99 [2.63, 3.35]
15.Zhu 2012 (EA)		5.04%	1.95 [1.41, 2.48]
15.Zhu 2012 (CT)		5.05%	1.47 [0.95, 1.99]
15.Zhu 2012 (EA + CT)		4.91%	3.65 [2.91, 4.39]
RE Model		100.00%	1.29 [0.58, 2.00]

-2 0 2 4 6

Fig. 2 Forest plot showing standardized mean difference (95% CI) and the studies weighted regarding different interventions to reduce problematic internet use. **Notes:** (i) The repeating studies in the plot indicate the effect of each separate intervention; (ii) the studies 1, 2, 6, 9, 11, and 13 were compared with control groups, and the others were compared before and after the intervention; (iii) we excluded studies 8 and 12 from this plot due to the impossibility of calculating the standardized mean difference based on the data available in these articles

These results may be related not only to the methodological characteristics of the studies (which are largely like each other) but also to the interventions' profile (type of therapist, group or individual therapy, length of time, participant engagement, rate drop out, etc.). In the review by Lee et al. (2019) regarding the prevention strategies and interventions for PIU, the authors listed some challenges to effective prevention and intervention programs focused on PIU. First, there are few studies on this topic because the concept of PIU is relatively new and complex as it must be considered in the context of how people handle with the speed of the development of new technologies. Second, it is plausible that several forms of PIU exist (different factors linked to the craving, abstinence, excessive use, etc.) because Internet use is strongly connected with different technologies (smartphone usage, video games, watching videos and movies, messaging, etc.), which can influence the strategic goals of each intervention.
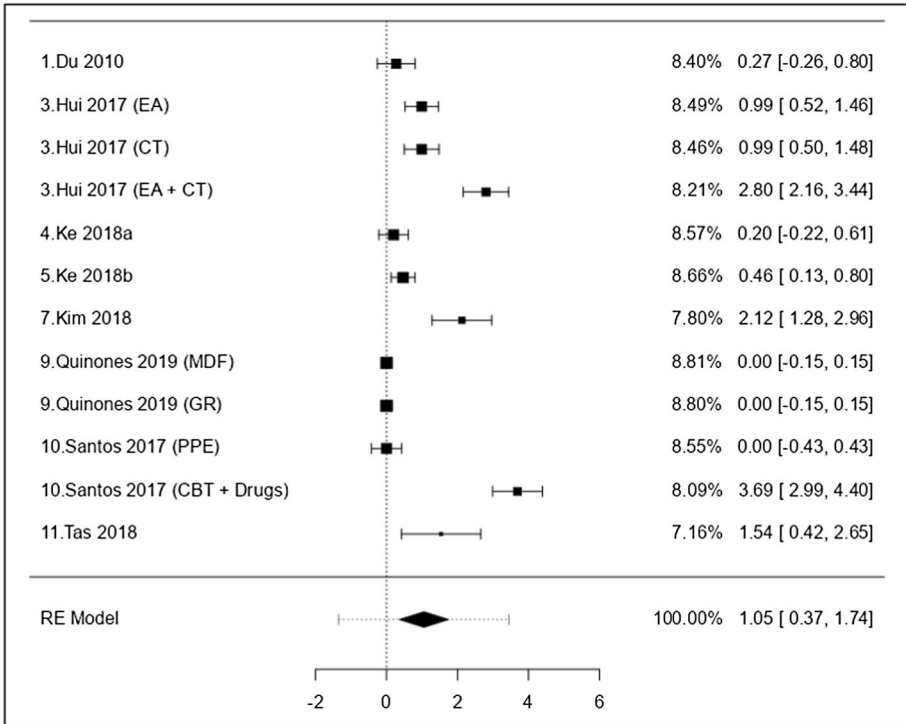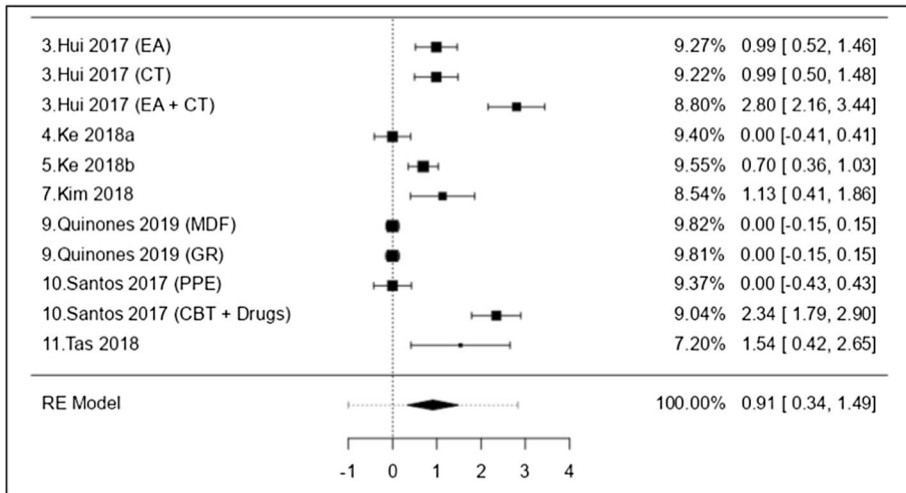
Fig. 3 Forest plot showing standardized mean difference (95% CI) and the studies weighted regarding different interventions to reduce anxiety symptoms among individuals with PIU. **Notes:** (i) The repeating studies in the plot indicate the effect of each separate intervention; (ii) the studies 1, 9, and 11 were compared with control groups, and the others were compared before and after the intervention

Effects on Symptoms of Depression

For depression (Fig. 4), 11 interventions were analyzed from 7 studies. The observed standardized mean differences ranged from 0.00 to 2.79, with the most positive estimates (64%). Therefore, the mean outcome differed significantly from zero ($z = 3.12$, $p < 0.01$). According to the Q-test, the true outcomes appear to be heterogeneous (Q (10) = 174.56, $p < 0.01$, $tau^2 = 0.8670$, $I^2 = 96.84\%$). According to Cook's distances, none of the studies were considered overly influential.

In addition to identifying the effect on reducing PIU symptoms, anxiety was the most studied disorder ($n = 8$, 53.3%), followed by depression ($n = 7$; 46.6%). These data are in accordance with findings indicating a high prevalence of mood and anxiety disorders in individuals with PIU (Andrade et al., 2020a, 2020b, 2020c; Faghani et al., 2020). One of the causes may be related to neurochemical mechanisms in common neural pathways, for addictive behaviors and depression and anxiety. It is well well-known that individuals who use substances have hyperactivation of dopaminergic pathways (e.g., mesolimbocortical) and consequent release of dopamine in the nucleus accumbens (Chun et al., 2018). These findings have also been detected in preclinical studies (Burton et al., 2015) and among depressive patients with severe symptoms of anhedonia (Foell et al., 2021). Hyperactivation of glutamatergic pathways from the prefrontal cortex to the nucleus accumbens has

3.Hui 2017 (EA)	9.27%	0.99 [0.52, 1.46]
3.Hui 2017 (CT)	9.22%	0.99 [0.50, 1.48]
3.Hui 2017 (EA + CT)	8.80%	2.80 [2.16, 3.44]
4.Ke 2018a	9.40%	0.00 [-0.41, 0.41]
5.Ke 2018b	9.55%	0.70 [0.36, 1.03]
7.Kim 2018	8.54%	1.13 [0.41, 1.86]
9.Quinones 2019 (MDF)	9.82%	0.00 [-0.15, 0.15]
9.Quinones 2019 (GR)	9.81%	0.00 [-0.15, 0.15]
10.Santos 2017 (PPE)	9.37%	0.00 [-0.43, 0.43]
10.Santos 2017 (CBT + Drugs)	9.04%	2.34 [1.79, 2.90]
11.Tas 2018	7.20%	1.54 [0.42, 2.65]
RE Model	100.00%	0.91 [0.34, 1.49]

Fig. 4 Forest plot showing standardized mean difference (95% CI) and the studies weighted regarding different interventions to reduce depression symptoms among individuals with PIU. **Notes:** (i) The repeating studies in the plot indicate the effect of each separate intervention; (ii) the studies 9 and 11 were compared with control groups, and the others were compared before and after the intervention

been associated with fissure and withdrawal (Murray et al., 2021) but may also be related to anxiety symptoms (Nasir et al., 2020).

Therefore, the greater the levels of anxiety and depression, the greater the intensity of Internet use. Consequently, this overuse may further increase these symptoms due to cognitive bias (Sussman et al., 2016). In the updated I-PACE model (Brand et al., 2019), a cognitive bias is a component that influences individuals' decision-making based on coping strategies for stressful situations. Thus, when individuals cannot handle effectively with stressful situations, they may resort to escape/avoidance behaviors through different devices with Internet access. Therefore, cognitive bias may have an indirect effect on PIU as a mediating role. Previous findings support this hypothesis. In a study conducted with 219 Serbian children, psychopathological symptoms had a mediating effect on irrational beliefs and PIU (Vukosavljevic-Gvozden et al., 2015). Furthermore, the most influential mediating variable was derived from the symptoms of obsessive–compulsive disorder. Regarding irrational beliefs, low frustration tolerance was positively correlated with the length of time using video games. According to the authors mentioned above, when an individual is facing a stressful event in their real life, they believe that they are not able to handle the situation, leading them to seek immediate gratification from the Internet, which increases the risk of PIU (Vukosavljevic-Gvozden et al., 2015).

Limitations

Our research has methodological limitations. First, we included studies with small samples and others that did not have control groups. Second, as the definition of PIU is still broad in the literature, we included all studies that measured PIU based on at least a specific validated instrument or questions related to Internet use. However, we did not consider smartphone or video game addiction, which can be a confounding variable with PIU (Montag &

Rumpf, 2021). The included studies also have limitations that should be considered. First, in our quality assessment, several studies did not provide adequate information. For example, two studies (Table 2, studies 8 and 12) did not report mean and standard deviation information and were not included in the meta-analysis. Second, the date on which the studies were conducted wasn't indicated, which is important due to how the Internet interacts with the advancement of technological development. This difficulty was also reported in a recent systematic review evaluating the association between PIU and substance use (Lanthier-Labonté et al., 2020).

Conclusion and Future Directions

In summary, although we found that psychosocial interventions effectively reduced PIU, depression, and anxiety, in individuals with PIU no specific psychosocial intervention was overly influential compared to each other in reducing PIU symptoms and depression. Only one study was found to be influential in reducing anxiety symptoms (CBT + pharmacotherapy). Further research is needed to investigate the effect of other modalities as their use in reducing PIU symptoms is still recent. Furthermore, more longitudinal studies are needed to examine whether the improvements in reducing symptoms of PIU, anxiety, and depression are stable, given that most studies reported a follow-up period of 1 month. Qualitative studies that assess the impact of these interventions could also contribute to a better understanding of how these interventions can benefit participants.

Appendix. ROBIS Checklist

Phase 1: Assessing relevance (optional)

Category	Target question (e.g., overview or guideline)	Review being assessed
Patients/population(s)	Individuals with problematic internet use	How effective are psychological treatments/interventions for reducing symptoms of PIU, depression, and anxiety in individuals with problematic Internet use?
Intervention(s)	Psychotherapeutic; psychoeducational; psychosocial	
Comparator(s)	No intervention or intervention gold standard	
Outcome(s)	Treatment effectiveness for Internet abuse and the variables: anxiety and depression	

Phase 2: Identifying concerns with the review process

Legend: **Y**=Yes, **PY**=Probably yes, **PN**=Probably no, **N**=No, **NI**=No information

Domain 1: Study eligibility criteria	
1.1 Did the review adhere to pre-defined objectives and eligibility criteria?	Y/PY/**PN**/N/NI
1.2 Were the eligibility criteria appropriate for the review question?	Y/PY/PN/N/NI
1.3 Were eligibility criteria unambiguous?	Y/PY/PN/N/NI
1.4 Were any restrictions in eligibility criteria based on study characteristics appropriate (e.g., date, sample size, study quality, outcomes measured)?	Y/PY/PN/N/NI
1.5 Were any restrictions in eligibility criteria based on sources of information appropriate (e.g., publication status or format, language, availability of data)?	Y/PY/PN/N/NI
Domain 2: Identification and selection of studies	
2.1 Did the search include an appropriate range of databases/electronic sources for published and unpublished reports?	Y/PY/PN/N/NI
2.2 Were methods additional to database searching used to identify relevant reports?	Y/PY/PN/N/NI
2.3 Were the terms and structure of the search strategy likely to retrieve as many eligible studies as possible?	Y/PY/PN/N/NI
2.4 Were restrictions based on date, publication format, or language appropriate?	Y/PY/PN/N/NI
2.5 Were efforts made to minimize error in selection of studies?	Y/PY/PN/N/NI
Domain 3: Data collection and study appraisal	
3.1 Were efforts made to minimize error in data collection?	Y/PY/PN/N/NI
3.2 Were sufficient study characteristics available for both review authors and readers to be able to interpret the results?	Y/PY/PN/N/NI
3.3 Were all relevant study results collected for use in the synthesis?	Y/PY/PN/N/NI
3.4 Was risk of bias (or methodological quality) formally assessed using appropriate criteria?	Y/**PY**/PN/N/NI
3.5 Were efforts made to minimize error in risk of bias assessment?	Y/PY/PN/N/NI
Domain 4: Synthesis and findings	
4.1 Did the synthesis include all studies that it should?	**Y**/PY/PN/N/NI
4.2 Were all pre-defined analyses reported or departures explained?	Y/**PY**/PN/N/NI
4.3 Was the synthesis appropriate given the nature and similarity in the research questions, study designs, and outcomes across included studies?	Y/PY/PN/N/NI
4.4 Was between-study variation (heterogeneity) minimal or addressed in the synthesis?	Y/**PY**/PN/N/NI
4.5 Were the findings robust, e.g., as demonstrated through funnel plot or sensitivity analyses?	Y/PY/PN/**N**/NI
4.6 Were biases in primary studies minimal or addressed in the synthesis?	**Y**/PY/PN/N/NI

Phase 3: Judging risk of bias (summarize the concerns identified during the phase 2 assessment).

Domain	Concern	Rationale for concern
1. Concerns regarding specification of study eligibility criteria	LOW	According to the criteria identified in domain 1, the risk potential is LOW because the analyses included all information
2. Concerns regarding methods used to identify and/or select studies	LOW	All criteria for study identification and selection were met and included in this paper
3. Concerns regarding methods used to collect data and appraise studies	LOW	All three domain criteria are detailed in the manuscript, reducing the risk of bias
4. Concerns regarding the synthesis and findings	LOW	Based on the items suggested in the results summary, item 4.6 was not conducted. As for item 4.2, the participants' losses were not detailed. Although most studies used CBT, other therapies were also detected, making the results more imprecise
Risk of bias in the review		
Describe whether conclusions were supported by the evidence: Some studies had small sample sizes, and others had no control groups; there was difficulty in defining PIU (problematic internet use) in some papers		
A. Did the interpretation of findings address all the concerns identified in Domains 1 to 4?	**Y/PY/PN/N/NI**	
B. Was the relevance of identified studies to the review's research question appropriately considered?	**Y/PY/PN/N/NI**	
C. Did the reviewers avoid emphasizing results based on their statistical significance?	**Y/PY/PN/N/NI**	
Risk of bias in the review	**LOW**/HIGH/UNCLEAR	
Rationale for risk: Two reviewers performed the first assessment paired and independently based on the FINER criteria and the PICOS strategy. Three further reviewers evaluated independently, blindly, and critically the inclusion or exclusion of the 32 selected articles. These manuscripts were read and evaluated in full by a fourth reviewer. All reviewers were experts in the field of Internet addiction. The evaluations were conducted autonomously, and disagreements were discussed via online meetings		

Author Contribution André Luiz Monezi Andrade: Conceptualization, methodology, formal analysis, original draft writing. Gabriella Di Girolamo Martins: Conceptualization, Data curation, review and editing. Adriana Scatena: Conceptualization, methodology, review and editing. Fernanda Machado Lopes: Methodology, formal analysis, review and editing. Wanderlei Abadio de Oliveira: Methodology, review and editing. Hyoun S Kim: Methodology, review and editing. Denise de Micheli: Conceptualization, methodology, supervision, project administration.

Declarations

Conflict of Interest The authors declare no competing interests.

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