Associations Between Behavioral Addictions and Mental Health Concerns During the COVID-19 Pandemic: A Systematic Review and Meta-analysis

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Abstract

Purpose of Review The COVID-19 pandemic has promoted behavioral changes and elevated mental distress. Addictive behaviors often increased, generating mental health problems. The present study's primary aim was to investigate associations between different types of behavioral addictions (including behavioral addictions, related conditions, and phenomena) and different types of mental health problems. The secondary aims were: (i) to identify possible sources of heterogeneity and (ii) to explore potential moderators in associations between different types of behavioral addictions (including behavioral addictions, related conditions, and phenomena) and different types of mental health problems.

Recent Findings Using Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA), studies from the period between December 2019 and May 2023 were sought from *PubMed*, *Scopus*, *ISI Web of Knowledge*, and *Google Scholar* in its first ten pages. The articles' relevance was screened and evaluated. The included papers' quality was assessed according to the Newcastle Ottawa Scale. Fisher's Z scores were computed to present magnitudes of associations and I^2 indices were used to estimate levels of heterogeneity in the meta-analysis. Among the 85 included studies (N = 104,425 from 23 countries; mean age = 24.22 years; 60.77% female), most were internet-related behavioral addictions, related conditions, and phenomena (28 studies on social media, 25 on internet, 23 on smartphone, and 12 on gaming). The pooled estimation of the associations showed that higher levels of behavioral addictions, related conditions, and phenomena related to internet use (regardless of type) were associated with more mental health problems (regardless of which type). Moderator analyses showed that almost no variables affected heterogeneity for the founded associations.

Summary Most studies of behavioral addictions, related conditions, and phenomena focused on internet-related behaviors, with studies suggesting relationships with specific types of mental health problems during the COVID-19 pandemic. Moreover, associations between behavioral addictions (including behavioral addictions, related conditions, and phenomena) and mental health problems found in the present systematic review and meta-analysis were comparable to the associations identified in studies conducted before the COVID-19 pandemic. How to help people reduce internet-related behavioral addictions, related conditions, and phenomena and address associated mental health concerns are important topics for healthcare providers.

Keywords Addictive behaviors · Video games · COVID-19 · Distress · Internet addiction · Psychosocial health

Introduction

Although COVID-19-related concerns may be diminishing globally [1], pandemic-related impacts on human behaviors warrant further examination [2]. History suggests that intervals between regional or global events involving severe infectious diseases have become progressively shorter. For example, major events include the Spanish Flu around 1918, the Asian Flu and Hong Kong Flu around 1957, the severe acute respiratory syndrome coronavirus (SARS-CoV) around 2002, the Ebola virus disease around 2013, and the COVID-19 pandemic around 2019 [3]. Thus, people may encounter future concerns comparable to the COVID-19 pandemic, perhaps relatively soon. Therefore, it is important to understand the impacts that COVID-19 has exerted on human health, including mental health.

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The COVID-19 pandemic substantially changed human behaviors, lifestyles, and mental health concerns both directly (e.g., people afraid of COVID-19 infections often changed their lifestyles) and indirectly (e.g., governments implemented policies such as lockdowns to avoid infectious transmission) [4–7]. Both direct or indirect impacts may have promoted increased addictive behaviors [8••, 9•] and worsened mental health problems [10–12] during the pandemic. For example, Chinese primary school children spent more time on smartphones and using social media during versus before the COVID-19, with higher levels of social media addiction, gaming addiction, and psychological distress during the pandemic [13]. These findings reflect resonate with other qualitatively and quantitatively synthesized evidence suggesting both behavioral addictions (including behavioral addictions, related conditions, and phenomena) and mental health problems during the COVID-19 pandemic [8••, 9•, 10–12].

Data suggest behavioral addictions (including behavioral addictions, related conditions, and phenomena) and mental health problems negatively impact general well-being [14, 15, 16•, 17–21]. Behavioral addictions (including behavioral addictions, related conditions, and phenomena) may generate serious health issues for people, and several behavioral addictions (e.g., related to gaming and gambling) have been identified as disorders in both the ICD-11 [22] and DSM-5 [23]. Specifically, gaming and gambling disorder are included in the ICD-11, while internet gaming disorder is proposed to be a condition for further study in the DSM-5. Some putative behavioral addictions (e.g., problematic use of social media) are not yet included in either nomenclature system due to limited data. However, clinicians may encounter patients with such concerns, and the ICD-11 diagnostic entity of "specified disorders due to addictive behaviors" has been proposed for use in such circumstances [24]. Furthermore, several existing theories (e.g., the Interaction of Person-Affect-Cognition-Execution [I-PACE] model; Compensatory Internet Use Theory) have been proposed to explain the development of different types of behavioral addictions [25, 26]. However, the evidence regarding different types of behavioral addictions is not only debated but also scattered in the literature [27]. Therefore, it is important to synthesize evidence for healthcare providers and researchers to better understand the clinical correlates of specific behavioral addictions, related conditions, and phenomena.

An important issue regarding behavioral addictions, related conditions, and phenomena involves understanding their relationships with other mental health concerns. It is important to identify how behavioral addictions, related conditions, and phenomena relate to mental health problems for many reasons. For example, the WHO has stated that there is no health without mental health [28, 29]. Therefore, healthcare providers should help improve individuals' mental health via identifying and addressing factors contributing to mental health problems. Multiple behavioral addictions, related conditions, and phenomena have been associated with poor mental health, including before the COVID-19 pandemic [30–32]. These relationships may have changed during the pandemic [33–35], especially given changes in use of digital technologies [36, 37].

However, there is no accumulated evidence regarding associations between behavioral addictions (including behavioral addictions, related conditions, and phenomena) and mental health problems during the COVID-19 pandemic, especially regarding relationships between individual behavioral addiction and specific mental health concerns. Because prior evidence suggests that the COVID-19 pandemic worsened people's mental health problems and behavioral addictions (including behavioral addictions, related conditions, and phenomena) [8••, 9•, 10, 12], it is important to examine how specific behavioral addictions (including behavioral addictions, related conditions, and phenomena) related to specific mental health problems during the pandemic. Such information may help healthcare providers currently and during potentially similar future situations.

Study Aim

The present study's primary aim was to investigate relationships between different types of behavioral addictions (including internet addiction, gaming addiction, smartphone addiction, social media addiction, and other behavioral addictions)[1] and different types of mental health problems (including COVID-19-specific anxiety, sleep disorders, fear of COVID-19, cyberchondria, anxiety, depression, loneliness, alexithymia, stress, and psychological distress). The secondary aims were: (i) to identify possible sources of heterogeneity and (ii) to explore potential moderators in associations between different types of behavioral addictions (including behavioral addictions, related conditions, and phenomena) and different types of mental health problems.

Methods

Design and Registration

This manuscript followed Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines

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[1] Please note that these terms were used for literature search. However, some conditions (e.g., smartphone addiction) are not considered distinct and agreed-upon disorders. Please see Montag et al. How to overcome taxonomical problems in the study of Internet use disorders and what to do with "smartphone addiction"? *Journal of behavioral addictions*. 2021;9(4):908–14 for details.

[38]. The protocol was registered within the international prospective register of systematic reviews PROSPERO (Decree code: CRD42022330898) [39]. This systematic review project was planned with two main objectives: the first objective was to estimate the prevalence of behavioral addictions, related conditions, and phenomena during the COVID-19 pandemic, which has been published elsewhere [8••]; the second objective was to examine its association with different types of mental health problems reported here.

Eligibility Criteria

Based on PECO-S components [40], the eligibility criteria were defined as follows:

- Individuals with any type of behavioral addictions, related conditions, and phenomena (assessed using valid and reliable measures) at any age or gender group were eligible as the Population;
- COVID-19 pandemic was defined as the Exposure;
- People without behavioral addiction were considered for Comparison;
- Associations between behavioral addictions (including behavioral addictions, related conditions, and phenomena) and mental health problems (assessed using valid and reliable measures) were selected as Outcomes;
- Study design: English language, peer-reviewed manuscripts reporting observational studies, including cross-sectional, cohort or case controls were considered eligible if sufficient data regarding associations of any type of behavioral addictions (including behavioral addictions, related conditions, and phenomena) with mental health problems among participants were reported.

Information Sources

Academic databases (i.e., *PubMed*, *Scopus*, and *ISI Web of Knowledge*) were searched systematically covering the publication period between December 2019 and May 2023. Reference lists of included studies and published systematic reviews as well as the first ten pages of *Google Scholar* for each type of behavioral addiction were searched.

Search Strategy

The main search terms were selected based on a PECO-S search strategy [40]. Two main components of exposure (COVID-19 pandemic) and population (individuals with any type of behavioral addictions, related conditions, and phenomena) were selected. The main search terms were (internet OR "social media" OR smartphone OR "mobile phone" OR "cell phone" OR gaming OR "video gam*" OR "social network*" OR Twitter OR Instagram OR "YouTube" OR

"Facebook" OR "WhatsApp" OR "TikTok" OR "WeChat" OR "SnapChat" OR "QQ" OR "Tinder" OR gambl* OR betting OR "electronic gaming machines" OR lotto OR casino OR poker OR bingo OR blackjack OR lottery OR "slot machine*" OR exercis* OR "physical activity" OR pornography OR sex* OR food OR "binge eating" OR mukbang OR shopping OR buying OR technolog*) AND (addict* OR problem* OR depend* OR disorder* OR obsess* OR excess* OR compuls* OR impuls* OR excess*) AND ("SARS-CoV-2" OR "coronavirus" OR "COVID-19" OR "2019-nCoV" OR "coronavirus disease-2019" OR covid OR coronavirus OR "2019-ncov" OR "sars-cov-2" OR "cov-19").

Selection Process

First, the titles and abstracts of retrieved manuscripts were screened for relevance by two independent reviewers. The full texts of potentially relevant studies were further examined based on the aforementioned eligibility criteria. In this process, relevant studies were selected for further analysis. Disagreements between reviewers were resolved through discussion.

Data collection process and items

After selecting eligible papers, two reviewers independently extracted data using a pre-designed Excel spreadsheet. The Excel spreadsheet contained the following information for extracting data: first author's name, publication date, study design, country (or countries) where data were collected, number of participants, age range and mean, scales used to assess behavioral addictions (including behavioral addictions, related conditions, and phenomena) and mental health problems, data collection method, country's income status based on world bank reports, type of behavioral addiction, type of mental health concern, and numerical results regarding relationships between behavioral addictions (including behavioral addictions, related conditions, and phenomena) and mental health concerns. Disagreements between independent reviewers were resolved through discussion.

Study Risk of Bias Assessment

The Newcastle Ottawa Scale (NOS) for cross-sectional studies was used to assess included risk of bias regarding selection, comparability, and outcome assessment items. Each item was rated with one star (except for comparability, which can have two stars) for a maximum possible score of nine. Studies were categorized as low risk of bias when scoring above five points [41].

Effect Measure

The selected measure of effect for meta-analysis was the Pearson's correlation coefficient in the associations between a behavioral addiction and mental health concern.

Synthesis Methods

Data were synthesized using STATA software version 14 applying random effect models because the included studies involved different populations. Pearson's *r*-correlation coefficients were converted to Fisher's Z scores (using the following formula: $z = 0.5 \times \ln[(1+r)-(1-r)]$), due to the potential instability of variance [42, 43]. Therefore, all analyses were performed using Fisher's Z-values as main effect sizes (ESs). The standard error of Z was calculated based on the following formula: $SEz = 1/\sqrt{(n-3)}$ [44]. Fisher's Z is interpreted as weak at 0.1; weak to moderate at 0.1 to 0.3; moderate at 0.3; moderate to strong at 0.3 to 0.5; and as strong at 0.5 or above. Also, severity of heterogeneity was estimated using the I^2 index and interpreted as (i) mild ($I^2 < 25\%$), (ii) moderate ($25\% < I^2 < 50\%$), (iii) severe ($50\% < I^2 < 75\%$), and (iv) highly severe ($I^2 > 75\%$) [45].

Reporting Bias Assessment

Primarily, it was planned to assess publication bias based on Funnel plots and the Begg's Test [46]. However, due to the low number of studies in each subgroup (less than ten studies in most groups) [47], it was not possible to assess publication bias or conduct further sensitivity analysis. Therefore, bias assessment was not examined using Funnel plots or Begg's Test.

Moderator Analysis

In moderator analyses, subgroups with more than four studies were selected to conduct meta-regression. Due to the low number of included studies in each group (which limited the application of significance values), considerable values of adjusted R^2 for examined variable were reported as possible moderators.

Results

Study Screening and Selection Process

The systematic search in academic databases resulted in 19,265 papers: *ISI Web of Knowledge* ($n=6996$), *Scopus* ($n=7824$), and *PubMed* ($n=4445$). Duplicates ($n=8464$) were removed; next, titles and abstracts of the remaining manuscripts were screened. Finally, 85 studies were included. Figure 1 shows the search process based on the PRISMA flowchart.

Study Description

Eighty-five cross-sectional studies involving 104,425 individuals from 23 countries (Bangladesh, Canada, China, Germany, India, Indonesia, Iran, Italy, Jordan, Kuwait, Lebanon, Lithuania, Malaysia, Palestine, Pakistan, Taiwan, Thailand, Turkey, Saudi Arabia, Spain, South Korea, UK, USA) were included. Seventeen studies (20%) gathered data during the national lockdown period in their respective countries. The smallest sample size was 32 (from the UK), and the largest sample size was 10,843 (from Iran). The mean age of participants was 24.22 years with ages ranging between 8 and 80 years. Most studies (54 out of 85) were conducted in high-income countries. All studies had both male and female participants (60.77% female). The main behavioral addictions, related conditions, and phenomena studied were social media use (28 studies), internet use (25 studies), smartphone use (23 studies), and gaming (12 studies). The other types of behavioral addictions, related conditions, and phenomena were investigated in few numbers of studies, including food addiction (two studies), eating disorder (one study), gambling disorder (one study), problematic pornography use (one study), binge watching (one study), exercise addiction (one study), and shopping addiction (one study). For the behavioral addictions, related conditions, and phenomena with very low number of studies (one or two), the specific behavioral addictions, related conditions, and phenomena were not included in the final meta-analysis. Table 1 provides the summary characteristics of all included studies.

Quality Assessment

Most studies (75 out of 85) were categorized as being of high quality (or low risk of bias). The scores reflecting methodological quality are provided in Table 1 with details in Fig. 2. The two main methodological problems of the included studies were:

i. Explanation regarding the response rate or the characteristics of the responders: almost all studies did not provide the information of non-responders (83 out of 85).
ii. Estimation of sample size or justification of sample size adequacy: most studies did not explain or justify their required sample size (66 out of 85).

Outcome Measures

Associations Between Internet Addiction and Mental Health Problems

The pooled estimated associations between internet addiction and mental health concerns are shown in Fig. 3 and listed below:

Fig. 1 Identification of studies via databases and registers
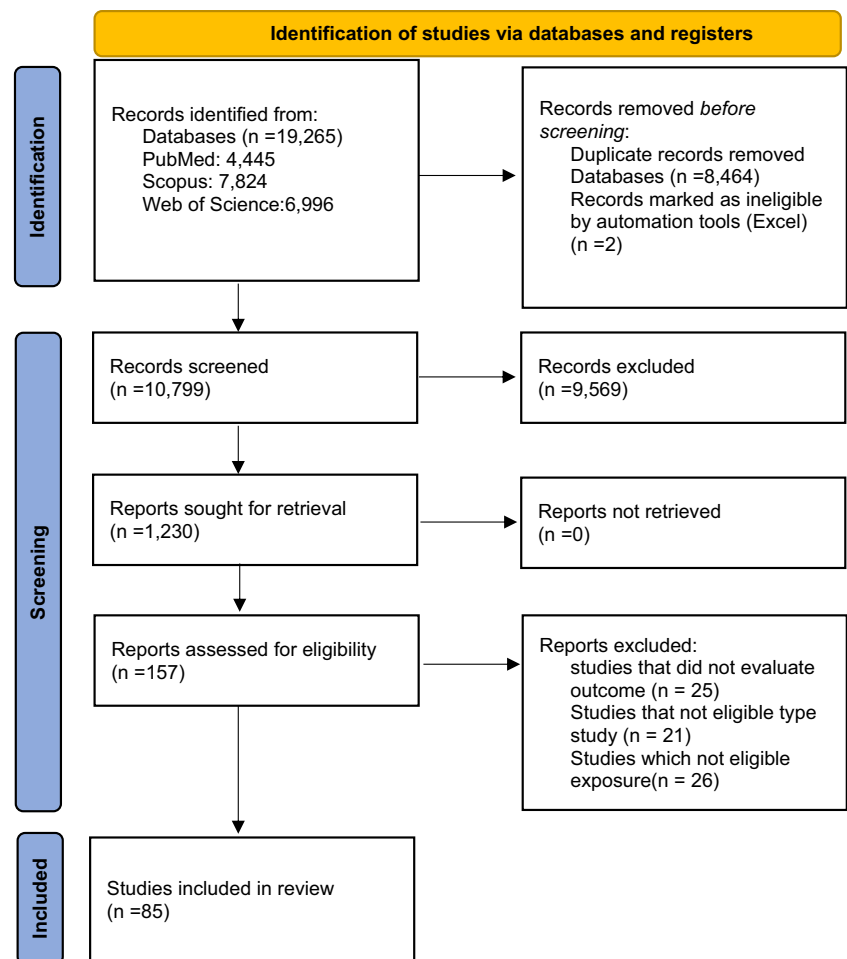
i. Association between internet addiction and *COVID-19-specific anxiety* was reported in two studies with 1144 individuals; pooled Fisher's Z score of 0.18 (95% confidence interval (CI): 0.12; 0.24, I^2: -, $\tau^2 < 0.001$).

ii. Association between internet addiction and *sleep disorder* was reported in six studies with 14,035 individuals; pooled Fisher's Z score of 0.28 (95% CI: 0.18; 0.39, I^2: 97.1%, $\tau^2 = 0.016$).

iii. Association between internet addiction and *fear of COVID-19* was reported in three studies with 3184 individuals; pooled Fisher's Z score of 0.29 (95% CI: 0.15; 0.42, I^2: 89.4%, $\tau^2 = 0.012$).

iv. Association between internet addiction and *cyberchondria* was reported in two studies with 1223 individuals; Pooled Fisher's Z score of 0.41 (95% CI: 0.28; 0.54, I^2: 80.3%, $\tau^2 = 0.007$).

v. Association between internet addiction and *anxiety* was reported in eight studies with 9161 individuals; pooled Fisher's Z score of 0.43 (95% CI: 0.34; 0.51, I^2: 92.2%, $\tau^2 = 0.01$).

vi. Association between internet addiction and *depression* was reported in nine studies with 12,823 individuals; pooled Fisher's Z score of 0.44 (95% CI: 0.37; 0.52, I^2: 93.5%, $\tau^2 = 0.01$).

vii. Association between internet addiction and *loneliness* was reported in five studies with 1583 individuals; pooled Fisher's Z score of 0.44 (95% CI: 0.36; 0.51, I^2: 44.5%, $\tau^2 = 0.003$).

viii. Association between internet addiction and *alexithymia* was reported in three studies with 1661 individuals; pooled Fisher's Z score of 0.46 (95% CI:—0.04; 0.96, I^2: 98.8%, $\tau^2 = 0.20$).

ix. Association between internet addiction and *stress* was reported in two studies with 1320 individuals; pooled Fisher's Z score of 0.49 (95% CI: 0.41; 0.58, I^2: 50.7%, $\tau^2 = 0.002$).

x. Association between internet addiction and *psychological distress* was reported in four studies with 2858 individuals; pooled Fisher's Z score of 0.55 (95% CI: 0.39; 0.71, I^2: 94.6%, $\tau^2 = 0.025$).

Table 1 Summarized characteristics of included studies

ID	First author, year	Lockdown	Country	Country income level	Age range	Age mean	Data collection method	Target population	Female %	Sample size	Type of behavioral addiction	NOS total score	NOS cat
120	Ballarotto G, 2021 [57]	No	Italy	High	18–25	22.96	Online	Adults	70	400	Internet and social media	6	Low risk of bias
100	Chang B, 2022 [58]	No	China	High		20.2	Other methods	Adults		924	Internet	6	Low risk of bias
1012	Zhao L, 2021 [59]	No	China	High	18–22	20.7	Online	Adults	66.4	500	Smartphone	6	Low risk of bias
1036	Brailovskaia J, 2021 [60]	Yes	Germany	High		22.5	Online	Adults	81	211	Social media	7	Low risk of bias
1037	Brailovskaia J-Substudy 1, 2021 [61]	No	Germany	High		27.52	Online	Adults	75.3	372	Social media	6	Low risk of bias
1037	Brailovskaia J- Sub study 2, 2021 [61]	Yes	Germany	High		25.82	Online	Adults	78.3	157	Social media	6	Low risk of bias
1037	Brailovskaia J- Substudy 3, 2021 [61]	No	Lithuania	High		19.45	Online	Adults	80.8	271	Social media	6	Low risk of bias
1037	Brailovskaia J- Substudy 4, 2021 [61]	Yes	Lithuania	High		19.7	Online	Adults	79.6	54	Social media	6	Low risk of bias
1076	Servidio R, 2021 [62]	No	Italy	High		21.9	Online	Adults		454	Internet	6	Low risk of bias
10n	Handique K, 2022 [63]	Yes	India	Lower- middle			Online	Adults	56	293	Gaming and internet and social media	5	High risk of bias
111	Karaoglan Yilmaz FG, 2022 [64]	No	Turkey	Upper-middle	17–54	22.71	Online	Adults	67	843	Smartphone	7	Low risk of bias
114	Hallauer CJ, 2021 [65]	Yes	China	High	12,19	15.34	Online	Adolescents	59.3	4752	Smartphone	6	Low risk of bias
12	La Rosa VL, 2021 [66]	Yes	Italy	High	20–80	37.55	Online	Adults	69.4	219	Internet	7	Low risk of bias
12new	Zaman M, 2022 [67]	No	Pakistan	Lower- middle	23–27		Online	General population	56.3	618	Gaming	7	Low risk of bias
171	Vismara M, 2021 [68]	No	Italy	High		33.6	Online	Adults	65.6	572	Internet	6	Low risk of bias

Table 1　(continued)

ID	First author, year	Lockdown	Country	Country income level	Age range	Age mean	Data collection method	Target population	Female %	Sample size	Type of behavioral addiction	NOS total score	NOS cat
19	Musetti A, 2022 [69]	No	Italy	High	19–48	28.49	Other methods	Adults	48.58	776	Pornography	5	High risk of bias
192	Zhang Y, 2022 [70]	No	China	High		17.01	Online	Adolescents		1148	Internet and smartphone	6	Low risk of bias
1n	Hao Z, 2022 [71]	No	China	High		20.1	Online	Adults	74.4	766	Smartphone	6	Low risk of bias
1new	Zhang J_T1, 2022 [72]	No	China	High		18.08	Other methods	Adults	52.72	1176	Smartphone	7	Low risk of bias
1new	Zhang J_T2, 2023 [72]	No	China	High		19.08	Other methods	Adults	52.72	1176	Smartphone	7	Low risk of bias
201	KalkanUğurlu Y, 2020 [73]	No	Turkey	Upper-middle	18–33	20.6	Online	Adults	79.3	411	Eating disorder	5	High risk of bias
202	Tahir MJ, 2021 [74]	No	Multi-country		15–44		Online	General population	64	2749	Internet	6	Low risk of bias
206	Lin C, 2020 [32]	No	Iran	Lower-middle		26.24	Online	Adults	41.74	1078	Social media	6	Low risk of bias
209	Elhai JD, 2020 [75]	No	China	High	17–64	40.37	Online	Adults	82.82	908	Smartphone	6	Low risk of bias
212	Gecaite-Stonciene J, 2021 [76]	No	Lithuania	High		21.73	Online	Adolescents	92.9	619	Internet	6	Low risk of bias
219	Fung XCC, 2021 [77]	No	China	High		11.6	Online	Adolescents	49	489	Smartphone and social media	7	Low risk of bias
231	Seyed Hashemi SG, 2020 [78]	No	Iran	Lower-middle	13–73	33.53	Online	General population	62.4	651	Internet	6	Low risk of bias
236	Zhao J, 2022 [79]	No	China	High		19.53	Online	Adults	56.67	373	Social media	6	Low risk of bias
237	Hammad MA, 2021 [80]	No	Saudi Arabia	High	16–60		Online	Adults	26.7	371	Social media	6	Low risk of bias
271	Ceci F, 2022 [81]	Yes	Italy	High		31.54	Online	Adults	66	953	Exercise	6	Low risk of bias
278	Boursier V, 2020 [82]	Yes	Italy	High	18–72		Online	Adults	48.03	3724	Social media	6	Low risk of bias
28	Zhen R, 2021 [83]	No	China	High	15–18		Other methods	Adolescents	44.1	683	Smartphone	5	High risk of bias

Table 1 (continued)

ID	First author, year	Lockdown	Country	Country income level	Age range	Age mean	Data collection method	Target population	Female %	Sample size	Type of behavioral addiction	NOS total score	NOS cat
2n	Yam FC, 2021 [84]	No	Turkey	Upper-middle	17–65	28.61	Online	Adults	64.4	520	Smartphone	6	Low risk of bias
2new	Reed P, sub-study 2, T1, 2023 [85]	No	UK	High		23.88	Online	Adults	68.29	41	Internet	5	High risk of bias
2new	Reed P- sub-study 1, T1, 2023 [85]	Yes	UK	High		26.62	Online	Adults	56.25	32	Internet	5	High risk of bias
356	Jiang M, 2021 [86]	No	China	High		20.49		Adults		2688	Internet	6	Low risk of bias
38	Boursier V, 2021 [87]	Yes	Italy	High	18–72	31.7	Online	Adults	71.5	715	Binge watching	6	Low risk of bias
395	Brailovskaia J, 2021 [88]	Yes	Spain	High		36.11	Online	Adults	82.4	221	Social media	7	Low risk of bias
3n	Sümen A, 2021 [89]	No	Turkey	Upper-middle		14.18	Online	Adolescents	70	1274	Social media	6	Low risk of bias
3new	Idris MF, 2023 [90]	No	Malaysia	Upper-middle	18–40	21.37	Online	Adults	44	213	Gaming	7	Low risk of bias
43	She R, 2021 [91]	No	China	High		13.6	Other methods	Adolescents	51.9	3136	Gaming	6	Low risk of bias
438	Ahorsu DK, 2022 [92]	No	Iran	Lower-middle		35.54	Other methods	Adults	62.3	10843	Social media	7	Low risk of bias
446	Yi J, 2021 [54]	Yes	China	High		33.94	Online	Adults	72.7	9030	Smartphone and social media	6	Low risk of bias
457	Ciccarelli M, 2022 [93]	No	Italy	High	18–29	22.24	Online	Adults	45.5	466	Gaming	6	Low risk of bias
459	Islam MS, 2021 [94]	No	Bangladesh	Lower-middle	18–25	21.2	Online	Adults	41.1	5511	Smartphone and social media	6	Low risk of bias
47	Teng Z, 2021 [95]	No	China	High			Online	Adolescents	49.32	1778	Gaming	7	Low risk of bias
472	Hosen I, 2021 [96]	No	Bangladesh	Lower-middle			Online	Adults	42.8	601	Smartphone	6	Low risk of bias
474	Alheneidi H, 2020 [97]	Yes	Kuwait	High	18–35		Online	Adults		593	Internet	7	Low risk of bias
476	Deutrom J, 2021 [98]	Yes	UK	High	18–69		Online	Adults	61.2	299	Internet	6	Low risk of bias

Table 1 (continued)

ID	First author, year	Lockdown	Country	Country income level	Age range	Age mean	Data collection method	Target population	Female %	Sample size	Type of behavioral addiction	NOS total score	NOS cat
48	Wang Y, 2022 [99]	No	China	High	12,15	13.07	Other methods	Adolescents	49.7	324	Gaming	5	High risk of bias
486	Elhai JD, 2020 [100]	No	Multi-country	High		44.45	Online	Adults	50.1	812	Gaming and smartphone	6	Low risk of bias
494	Brytek-Matera A, 2021 [101]	Yes	Lebanon	Lower-middle	18–65	29.86	Online	Adults	56.6	507	Food	7	Low risk of bias
497	Song Y, 2022 [102]	No	China	High	18–60		Online	Adults	60.7	666	Smartphone	6	Low risk of bias
4n	Chen CY-Wave 3, 2020 [50]	No	China	High		10.83	Online	Children		575	Gaming, smartphone, and social media	6	Low risk of bias
4new	Alabdallat YJ, 2023 [103]	No	Jordan	Upper-middle		18.99	Online	Adults	62.8	164	Smartphone	6	Low risk of bias
50	Cheng C, 2022 [104]	No	US	High	18–65	44.1	Online	Adults	53.81	1048	Social media	6	Low risk of bias
505	Zhang C, 2021 [105]	No	China	High		26.01	Online	Adults		1016	Smartphone	6	Low risk of bias
52	Duran S, 2022 [106]	No	Turkey	Upper-middle	13–18		Online	Adolescents		405	Social media	7	Low risk of bias
527	Jiang Y, 2021 [107]	No	China	High			Online	Adults	30.74	3123	Social media	6	Low risk of bias
542	Mahamid FA, 2021 [108]	No	Palestin	Lower-middle			Online	Adults	64.75	366	Internet	6	Low risk of bias
55	Güldal S, 2022 [109]	No	Turkey	Upper-middle	18–67	29.88	Online	Adults	78.5	376	Social media	6	Low risk of bias
566	Singh S, 2022 [110]	No	India	Lower-middle	13–60		Online	General population	58.76	1027	Internet	7	Low risk of bias
57	Arslan G, 2021 [111]	No	Turkey	Upper-middle	18–39	21.65	Online	Adults	67	315	Social media	5	High risk of bias
59	Sert HP, 2022 [112]	No	Turkey	Upper-middle	15–24	53.24	Online	Adolescents	78.3	924	Social media	6	Low risk of bias
5n	AlSumait L, 2021 [113]	No	Saudi Arabia	High	19–35		Online	Adults	68.9	618	Internet	5	High risk of bias
635	Arpaci I, 2021 [114]	No	Turkey	Upper-middle		22.16	Online	Adults		834	Social media	6	Low risk of bias

Table 1 (continued)

ID	First author, year	Lockdown	Country	Country income level	Age range	Age mean	Data collection method	Target population	Female %	Sample size	Type of behavioral addiction	NOS total score	NOS cat
671	Zhu S, 2021 [115]	No	China	High	8,17	12.6	Online	Adolescents	52.7	2863	Gaming	7	Low risk of bias
68	Lee JJ, 2022 [116]	No	South Korea	High	14–18		Online	Adolescents	49.18	1155	Internet	6	Low risk of bias
69	Peng Y, 2022 [117]	No	China	High		18.3	Online	Adults	51.91	628	Smartphone	6	Low risk of bias
6n	İlter SM, 2022 [118]	No	Turkey	Upper-middle	18–20		Online	Adults	75.2	202	Social media	5	High risk of bias
6new	Zeng M, 2022 [119]	No	China	High	17–27	19.75	Other methods	Adults	56.9	1843	Smartphone	7	Low risk of bias
74	Karakose T, 2022 [120]	No	Turkey	Upper-middle	20–65		Online	Adults	53	332	Social media	7	Low risk of bias
796	Liu S, 2022 [121]	Yes	China	High	10, 18	13.8	Online	Adolescents	51.5	4852	Internet	6	Low risk of bias
7n	Robert SJ, 2022 [122]	No	India	Lower- middle			Other methods	Adults		448	Internet	6	Low risk of bias
7new	Pattanaseri K, 2022 [123]	No	Thailand	Upper-middle		21.2	Online	Adults	50.5	1816	Gaming, social media, and eating disorder	6	Low risk of bias
8	Chang C, 2022 [124]	No	China	High	13–21	15	Online	Adolescents	41.5	1785	Gaming and smartphone	6	Low risk of bias
81	Siste K, 2021 [125]	Yes	Indonesia	Upper-middle		17.38	Online	Adolescents	78.7	2932	Internet	6	Low risk of bias
82	Lin M P, 2020 [126]	No	Taiwan	High		14.8	Other methods	Adolescents	48.36	1042	Internet	6	Low risk of bias
85	Ambrosin F, 2022 [127]	No	Italy	High	18–77	33.6	Online	Adults	66	572	Internet	6	Low risk of bias
865	Tang ACY, 2022 [128]	No	China	High	18–25		Online	Adults	35.31	337	Gambling	7	Low risk of bias
87	Kayis AR, 2021 [129]	No	Turkey	Upper-middle		34	Online	Adults	71.9	773	Smartphone	7	Low risk of bias
8n	Chen L, 2022 [92]	No	China	High	18–23		Online	Adults	67.3	480	Smartphone	6	Low risk of bias
935	Yusof M, 2021 [130]	No	Malaysia	Upper-middle	18–59		Online	Adults	75	444	Internet	7	Low risk of bias

575

Table 1 (continued)

ID	First author, year	Lockdown	Country	Country income level	Age range	Age mean	Data collection method	Target population	Female %	Sample size	Type of behavioral addiction	NOS total score	NOS cat
986	Singh S, 2021 [131]	No	India	Lower-middle	13–18		Online	Adolescents	58.42	1027	Gaming	7	Low risk of bias
9n	Kılınçel S, 2021 [132]	No	Turkey	Upper-middle	12, 18	15.6	Online	Adolescents	63.2	1142	Social media	6	Low risk of bias

Association Between Gaming Disorder and Mental Health Problems

The pooled estimated associations between gaming disorder and mental health problems are shown in Fig. 4 and listed below:

i. Association between gaming disorder and sleep disorder was reported in one study with 618 individuals; pooled Fisher's Z score of 0.10 (95% CI: 0.02; 0.18, I^2: -, $\tau^2 = $ -).

ii. Association between gaming disorder and loneliness was reported in two studies with 3329 individuals; pooled Fisher's Z score of 0.18 (95% CI: -0.01; 0.36, I^2: 92.9, $\tau^2 = 0.02$).

iii. Association between gaming disorder and depression was reported in nine studies with 12,674 individuals; pooled Fisher's Z score of 0.30 (95% CI: 0.22; 0.37, I^2: 94%, $\tau^2 = 0.01$).

iv. Association between gaming disorder and anxiety was reported in eight studies with 8534 individuals; pooled Fisher's Z score of 0.36 (95% CI: 0.25; 0.46, I^2: 95.1%, $\tau^2 = 0.02$).

v. Association between gaming disorder and stress was reported in six studies with 4108 individuals; pooled Fisher's Z score of 0.44 (95% CI: 0.33; 0.55, I^2: 90.7%, $\tau^2 = 0.02$).

Associations Between Smartphone Addiction and Mental Health Problems

The pooled estimated associations between smartphone addiction and mental health problems are shown in Fig. 5 and listed below:

i. Association between smartphone addiction and loneliness was reported in four studies with 4142 individuals; pooled Fisher's Z score of 0.25 (95% CI: 0.21; 0.29, I^2: 34.6%, $\tau^2 = 0.001$).

ii. Association between smartphone addiction and sleep disorder was reported in three studies with 3018 individuals; pooled Fisher's Z score of 0.30 (95% CI: 0.15; 0.46, I^2: 94.7%, $\tau^2 = 0.02$).

iii. Association between smartphone addiction and psychological distress was reported in two studies with 9803 individuals; pooled Fisher's Z score of 0.31 (95% CI: 0.21; 0.41, I^2: 86.4%, $\tau^2 = 0.005$).

iv. Association between smartphone addiction and stress was reported in five studies with 4186 individuals; pooled Fisher's Z score of 0.31 (95% CI: 0.11; 0.50, I^2: 97.4%, $\tau^2 = 0.05$).

**Fig. 2** Summarized methodological quality of included studies

Summarized methodological quality of included studies

Fig. 3 Associations between internet addiction and mental health problems
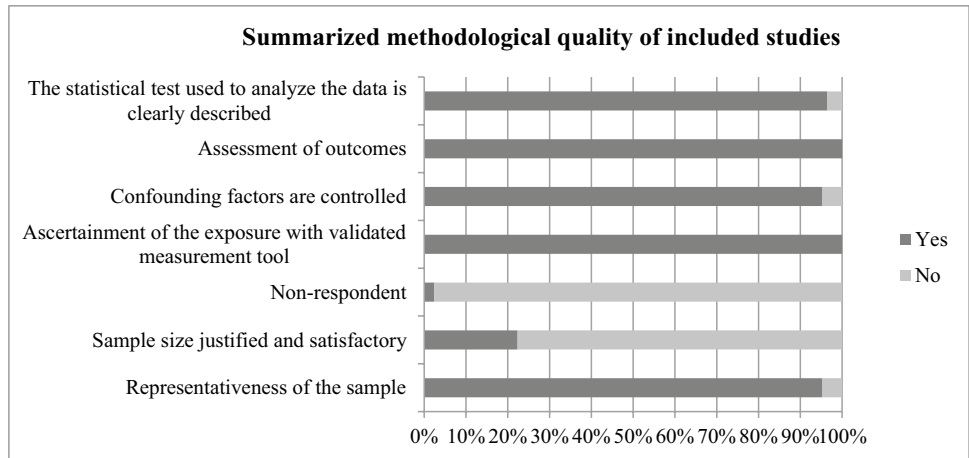
Associations between internet addiction and mental health problems

Fig. 4 Associations between gaming disorder and mental health problems
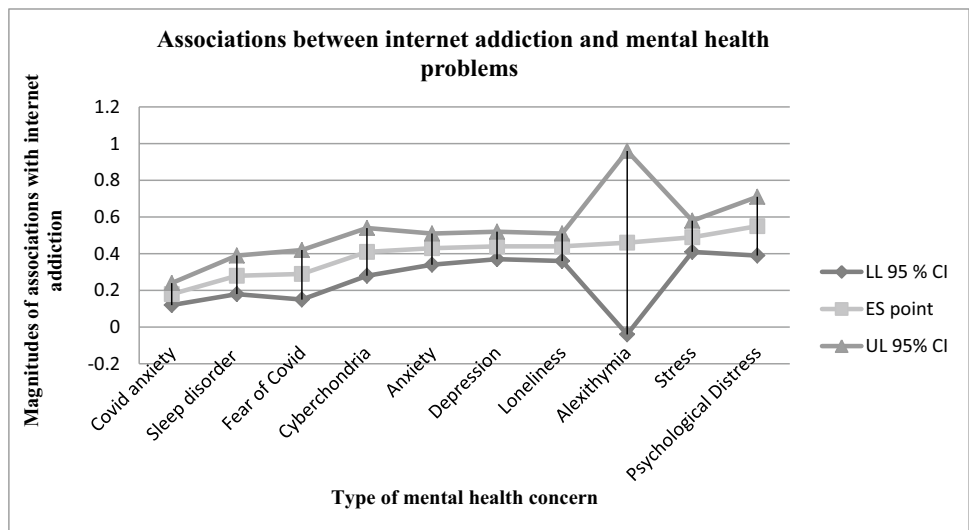
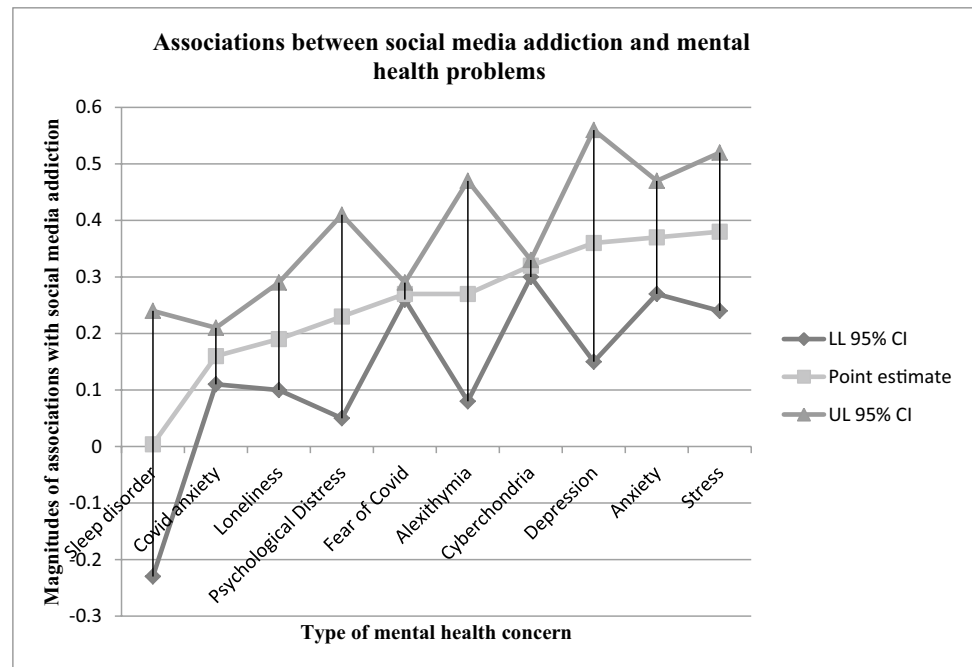Associations between gaming disorder and mental health problems
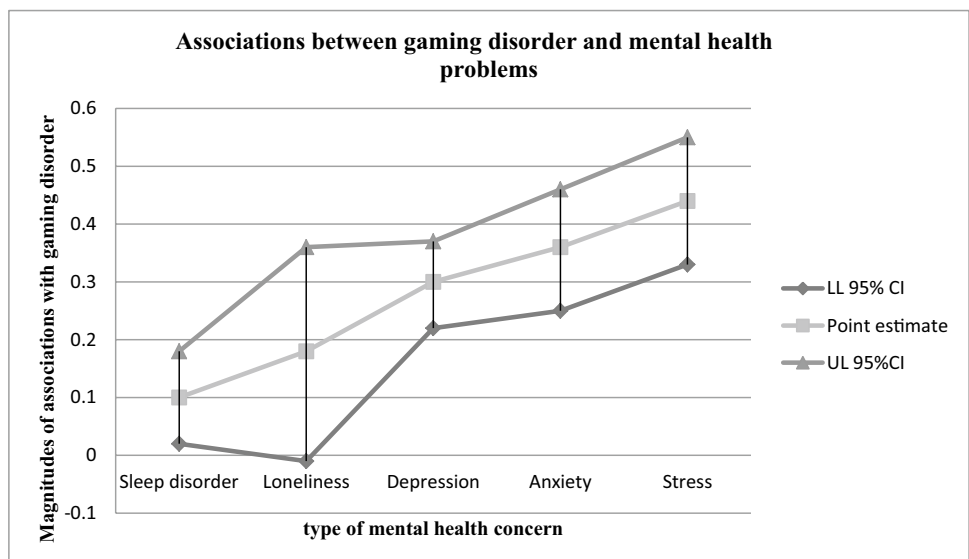
Fig. 5 Associations between smartphone addiction and mental health problems
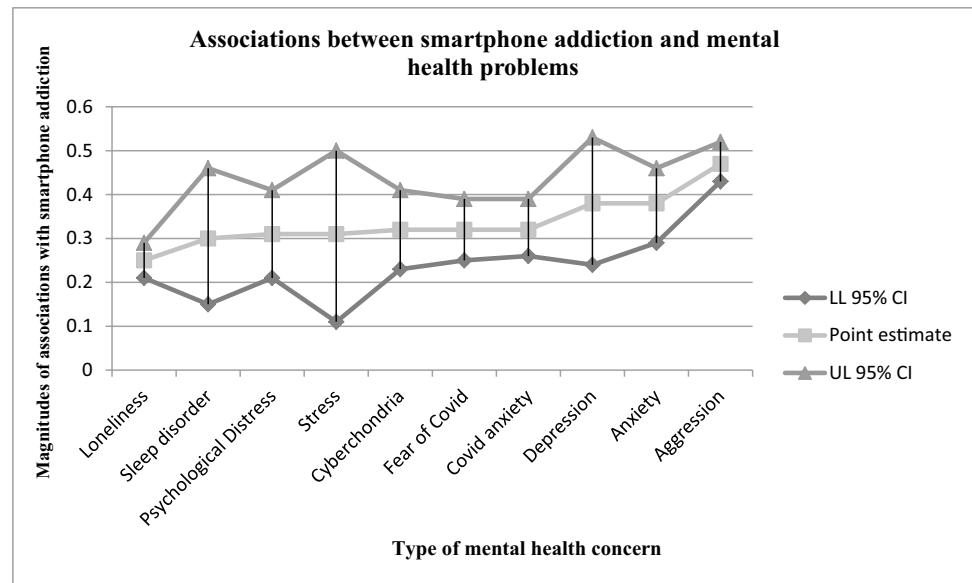
v. Association between smartphone addiction and cyberchondria was reported in one study with 520 individuals; pooled Fisher's Z score of 0.32 (95% CI: 0.23; 0.41, I^2: -, $\tau^2 = $ -).

vi. Association between smartphone addiction and fear of COVID-19 was reported in three studies with 10,320 individuals; pooled Fisher's Z score of 0.32 (95% CI: 0.25; 0.39, I^2: 77.4%, $\tau^2 = 0.003$).

vii. Association between smartphone addiction and COVID-19-specific anxiety was reported in one study with 908 individuals; pooled Fisher's Z score of 0.32 (95% CI: 0.26; 0.39, $I2$: -, $\tau^2 = $ -).

viii. Association between smartphone addiction and depression was reported in eight studies with 15,645 individuals; pooled Fisher's Z score of 0.38 (95% CI: 0.24; 0.53, $I2$: 98.6%, $\tau^2 = 0.04$).

ix. Association between smartphone addiction and anxiety was reported in twelve studies with 17,684 individuals; pooled Fisher's Z score of 0.38 (95% CI: 0.29; 0.46, I^2: 96.2%, $\tau^2 = 0.02$).

x. Association between smartphone addiction and aggression was reported in two studies with 1293 individuals; pooled Fisher's Z score of 0.47 (95% CI: 0.43; 0.52, I^2: 0%, $\tau^2 < 0.001$).

Association Between Social Media Addiction and Mental Health Problems

The pooled estimated associations between social media addiction and mental health problems are shown in Fig. 6 and listed below:

i. Association between social media addiction and sleep disorder was reported in three studies with 2757 individuals; pooled Fisher's Z score of 0.004 (95% CI: -0.23; 0.24, I^2: 97.2%, $\tau^2 = 0.02$).

ii. Association between social media addiction and COVID-19-specific anxiety was reported in three studies with 1615 individuals; pooled Fisher's Z score of 0.16 (95% CI: 0.11; 0.21, I^2: 6%, $\tau^2 = 0.0001$).

iii. Association between social media addiction and loneliness was reported in four studies with 6285 individuals; pooled Fisher's Z score of 0.19 (95% CI: 0.10; 0.29, I^2: 91.1%, $\tau^2 = 0.008$).

iv. Association between social media addiction and psychological distress was reported in two studies with 10,304 individuals; pooled Fisher's Z score of 0.23 (95% CI: 0.05; 0.41, I^2: 97.4%, $\tau^2 = 0.02$).

v. Association between social media addiction and fear of COVID-19 was reported in three studies with 20,951 individuals; pooled Fisher's Z score of 0.27 (95% CI: 0.26; 0.29, I^2: 15.1%, $\tau^2 < 0.001$).

vi. Association between social media addiction and alexithymia was reported in two studies with 602 individuals; pooled Fisher's Z score of 0.27 (95% CI: 0.08; 0.47, I^2: 80.3%, $\tau^2 = 0.015$).

vii. Association between social media addiction and cyberchondria was reported in one study with 10,843 individuals; pooled Fisher's Z score of 0.32 (95% CI: 0.30; 0.33, I^2: -, $\tau^2 = $ -).

viii. Association between social media addiction and depression was reported in eleven studies with 10,714 individuals; pooled Fisher's Z score of 0.36 (95% CI: 0.15; 0.56, I^2: 98.8%, $\tau^2 = 0.12$).

Fig. 6 Associations between social media addiction and mental health problems

ix. Association between social media addiction and anxiety was reported in twelve studies with 15,420 individuals; pooled Fisher's Z score of 0.37 (95% CI: 0.27; 0.47, I^2: 97%, $\tau^2 = 0.03$).

x. Association between social media addiction and stress was reported in eight studies with 2220 individuals; pooled Fisher's Z score of 0.38 (95% CI: 0.24; 0.52, I^2: 90.4%, $\tau^2 = 0.04$).

Moderator Analyses

Moderators were assessed using uni-variable meta-regression when there were at least four studies for analyses (Table 2).

Associations Between Internet Addiction and Mental Health Problems

Based on uni-variable meta-regression, none of the examined variables affected heterogeneity in the associations between internet addiction and mental health problems.

i. Moderators in the association between internet addiction and sleep disorder were country income level (0.09 increase in Fisher's Z score occurred by increasing the country income level, explaining 40% of variance, $p = 0.16$), and female percentage (0.01 decrease in Fisher's Z score occurred by increasing the percentage of female participants, explaining 69% of variance, $p = 0.12$).

ii. Moderators in the association between internet addiction and anxiety were country income level (0.13 decrease in Fisher's Z score occurred by increasing the country income level, explaining 71% of variance, $p = 0.009$); female percentage (0.006 decrease in Fisher's Z score occurred by increasing the percentage of female participants, explained 30% of variance, $p = 0.16$); target population (0.12 increase in Fisher's Z score occurred in each target group of adults, elders and general population compared to adolescents, explaining 36% of variance, $p = 0.08$).

iii. Moderators in the association between internet addiction and depression were study year (0.08 increase in Fisher's Z score occurred with each year increase, explaining 14% of variance, $p = 0.19$); female percentage (0.005 decrease in Fisher's Z score occurred by increasing the percentage of female participants, explaining 36% of variance, $p = 0.13$)

iv. None of the examined variables were significant moderators in the association between internet addiction and loneliness.

v. Moderators in the association between internet addiction and psychological distress were study year (0.14 decrease in Fisher's Z score occurred with each year increase, explaining 55% of variance, $p = 0.18$); country income level (0.14 increase in Fisher's Z score occurred by increasing the country income level, explaining 55% of variance, $p = 0.18$); target population (0.28 decrease occurred in each target group

Table 2 Results of uni-variable meta-regression analyses to identify moderators in associations between different behavioral addictions and mental health problems

Moderators	Type of mental health problem	Internet addiction					Gaming disorder			Smartphone addiction				Social media addiction			
		Sleep disorder	Anxiety	Depression	Loneliness	Psychological distress	Depression	Anxiety	Stress	Loneliness	Stress	Depression	Anxiety	Loneliness	Depression	Anxiety	Stress
	No	6	8	9	5	4	9	8	6	4	5	8	12	4	11	12	8
Study year	Coefficient	0.05	−0.06	−0.08	0.06	−0.14	0.04	−0.01	0.08	−0.03	−0.26	−0.06	−0.08	−0.04	−0.15	0.006	0.21
	p	0.65	0.42	0.19	0.38	0.18	0.58	0.86	0.56	0.59	0.16	0.55	0.10	0.63	0.26	0.96	0.18
	I^2 Residual (%)	96.86	92.99	93.42	57.34	86.64	92.81	95.73	92.55	51.70	95.80	98.08	94.76	90.38	97.58	96.78	88.83
	Adjusted R^2	−17.39	−3.21	13.67	−164.79	55.45	−7.75	−17.07	−17.30	−121.81	39.31	−6.59	17.57	−30.36	5.76	−10.98	19.01
Lockdown (Yes vs. No)	Coefficient	−0.02	0.13	0.03	−0.05		−0.13	−0.11	−0.19			0.02	0.05	0.13	−0.06	−0.06	−0.12
	p	0.86	0.27	0.79	0.67		0.40	0.53	0.35			0.92	0.74	0.22	0.68	0.50	0.41
	I^2 Residual (%)	97.61	90.88	94.28	55.92		94.71	95.75	91.99			98.75	96.42	74.84	98.91	96.18	90.32
	Adjusted R^2	−24.53	6.29	−13.81	−166.13		−3.21	−9.48	1.48			−17.04	−9.81	48.23	−7.64	−2.66	−1.49
Country income level	Coefficient	0.09	−0.13	−0.02		0.14	0.05	0.05	0.02	0.06		−0.06	−0.02	0.14	−0.09	−0.08	−0.03
	p	0.16	0.009	0.75		0.18	0.48	0.58	0.80	0.22		0.43	0.70	0.16	0.26	0.11	0.81
	I^2 Residual (%)	94.07	88.50	94.30		90.95	94.53	95.76	92.05	0		97.51	96.52	72.69	97.29	89.31	91.72
	Adjusted R^2	40.40	70.81	−11.74		54.68	−9.37	−11.37	−27.7	100		−3.15	−9.55	63.01	5.73	21.18	−17.42
Mean age	Coefficient	−0.01	0.005	−0.007	−0.002		0.002	0.005	−0.01	−0.0003	−0.01	−0.06	0.005		−0.006	−0.01	−0.02
	p	0.85	0.47	0.42	0.93		0.91	0.50	0.78	0.97	0.79	0.43	0.36		0.54	0.15	0.13
	I^2 Residual (%)	99.24	94.11	94.50	62.99		93.51	94.24	95.63	69.38	97.95	97.51	97.29		99.08	96.62	86.98
	Adjusted R^2	−89.72	−8.73	−3.93	−153.94		−21.59	−9.24	−46.13	−209.84	−30.5	−3.15	−0.45		−9.01	20.88	30.47
Female percentage	Coefficient	−0.01	−0.006	−0.005	−0.002		−0.007	−0.002	−0.001	−0.003	0.005	0.003	0.003	−0.002	−0.004	−0.003	−0.01
	p	0.12	0.16	0.13	0.93		0.49	0.86	0.93	0.26	0.61	0.67	0.43	0.72	0.35	0.16	0.01
	I^2 Residual (%)	90.94	88.91	91.54	62.99		93.60	95.55	91.27	3.26	96.99	98.71	96.64	91.72	98.37	97.09	68.99
	Adjusted R^2	68.99	30.16	36.40	−153.94		−5.97	−17.36	−29.9	−35.63	−20.2	−13.11	−2.54	−31.42	1.43	16.13	71.60
Target population	Coefficient	0.04	0.12	−0.05		−0.28	−0.03	0.02	−0.07	−0.05	0.05	0.11	0.11	0.14	−0.21	−0.17	−0.22
	p	0.59	0.08	0.58		0.10	0.77	0.87	0.68	0.44	0.84	0.40	0.25	0.16	0.36	0.26	0.28
	I^2 Residual (%)	97.55	92.23	93.69		76.23	94.11	94.75	92.54	41.33	97.36	98.05	96.08	72.69	98.96	97.30	89.15
	Adjusted R^2	−15.89	35.76	−8.86		76.71	−16.40	−16.94	−22.2	−35.63	−31.6	−1.58	6.13	63.01	−0.82	3.15	6.25

Table 2 (continued)

Type of behavioral addiction	Internet addiction					Gaming disorder			Smartphone addiction				Social media addiction			
Moderators / Type of mental health problem	Sleep disorder	Anxiety	Depression	Loneliness	Psychological distress	Depression	Anxiety	Stress	Loneliness	Stress	Depression	Anxiety	Loneliness	Depression	Anxiety	Stress
Significant moderators considering $p < 0.20$ as significant level	Country income level, Female percent	Country income level, Female percent, Target population	Study year, Female percent	-	Study year, country income level, Target population	-	-	-	-	Study year	-	Study year	Country income level, Target population	-	Country income level, Age mean, Female percent	Study year, Age mean, Female percent

of adults, elders and general population compared to adolescents, explaining 76% of variance, $p = 0.10$).

Associations Between Gaming Disorder and Mental Health Problems

None of the examined variables were moderators in associations between gaming disorder and depression, anxiety and stress.

Associations Between Smartphone Addiction and Mental Health Problems

i. None of the examined variables were moderators in the association between smartphone addiction and loneliness.

ii. The moderator in the association between smartphone addiction and stress was study year (0.26 decrease in Fisher's Z score occurred with each year increase, explaining 39% of variance, $p = 0.16$).

iii. None of the examined variables were moderators in the association between smartphone addiction and depression.

iv. The moderator in the association between smartphone addiction and anxiety was study year (0.08 decrease in Fisher's Z score occurred with each year increase, explaining 17.6% of variance, $p = 0.10$).

Associations Between Social Media Addiction and Mental Health Problems

i. Moderators in the association between social media addiction and loneliness were country income level (0.14 increase in Fisher's Z score occurred by increasing the country income level, explaining 63% of variance, $p = 0.16$) and target population (0.14 increase in Fisher's Z score occurred in each target group of adults, elders and general population compared to adolescents, explaining 63% of variance, $p = 0.16$).

ii. Moderators in the association between social media addiction and stress were female percentage (0.01 decrease in Fisher's Z score occurred with each percentage increase in female participants, explained 71.6% of variance, $p = 0.01$), mean age (0.02 decrease in Fisher's Z score occurred with each year increase in mean age of participants, explaining 30.47% of variance, $p = 0.13$), study year (0.21 increase in Fisher's Z score occurred with each year increase, explaining 19% of variance, $p = 0.18$)

iii. None of the examined variables were significant moderators in the association between social media addiction and depression.

iv. Moderators in the association between social media addiction and anxiety were country income level (0.08 decrease in Fisher's Z score occurred by increasing the country income level, explaining 21% of variance, $p = 0.11$), mean age (0.01 decrease in Fisher's Z score occurred with each year increase in mean age of participants, explaining 21% of variance, $p = 0.11$), female percentage of participants (0.003 decrease in Fisher's Z score occurred with each percentage increase in female participants, explaining 16% of variance, $p = 0.16$).

Discussion

Via rigorous and robust methodology used in systematic reviews and meta-analyses, we provide synthesized evidence regarding how specific behavioral addictions (including behavioral addictions, related conditions, and phenomena) related to specific types of mental health problems during the COVID-19 pandemic. Numerous studies have been conducted to understand associations between behavioral addictions (including behavioral addictions, related conditions, and phenomena) and mental health problems across different populations during the COVID-19 pandemic (please see Table 1 for detailed information). Most studies of behavioral addictions, related conditions, and phenomena focused on addictions related to social media, the internet, smartphones, and gaming. Other types of behavioral addictions, related conditions, and phenomena (i.e., related to food, eating, gambling, pornography use, binge watching, exercise, and shopping) remained understudied (only one or two studies for each type) and did not have sufficient data for further quantitative or qualitative synthesis. This finding suggests that most studies of behavioral addictions, related conditions, and phenomena focused on internet-related addictions (i.e., internet and smartphone addictions have been considered general forms of internet addiction; social media and gaming addictions have been considered specific forms of internet addiction) [9•, 48, 49].

Nevertheless, the present systematic review and meta-analysis synthesized the evidence regarding the associations between the four types of behavioral addictions (including behavioral addictions, related conditions, and phenomena) associated with internet use and a variety of mental health problems. In brief, higher levels of behavioral addictions, related conditions, and phenomena related to internet use (regardless of which type) were significantly associated with more mental health problems (regardless of which type of mental health problems), except for three associations: internet addiction with alexithymia, gaming addiction with loneliness, and social media addiction with sleep problems. Therefore, we conclude that internet-related behavioral

addictions (including behavioral addictions, related conditions, and phenomena) were typically associated with mental health problems during the COVID-19 pandemic, although the exceptions noted above warrant consideration (for example, decreased in-person social interactions during the pandemic could have been replaced by online gaming interactions, thus changing relationships between problematic gaming and loneliness, with longitudinal data resonating with this possibility [50]).

Three main reasons could explain the associations between internet-related behavioral addictions (including behavioral addictions, related conditions, and phenomena) and mental health problems. First, the COVID-19 pandemic may have increased urges to use the internet, potentially despite adverse consequences; that is, people were instructed not to leave their homes during lockdown periods and they may have used the internet to cope with stress or desires for social interaction [51, 52]. In this regard, people may have been more likely to develop or increase internet-related addictive behaviors, such as internet use, smartphone use, social media use, and gaming. As the COVID-19 pandemic often generated psychological distress, this may have led to mental health problems for people [52–54]. Accordingly, there may have been different reasons for increases in internet-related behavioral addictions (including behavioral addictions, related conditions, and phenomena) and mental health problems.

Second, the I-PACE model [55] could strengthen the first explanation to elaborate why internet-related behavioral addictions (including behavioral addictions, related conditions, and phenomena) were associated with mental health problems during COVID-19 pandemic. Specifically, the I-PACE model suggests that people may use internet activities as a coping method to cope with psychological distress. Some people who have problems in inhibiting the use of internet activities may then develop behavioral addictions, related conditions, and phenomena. In this regard, internet-related behavioral addictions, related conditions, and phenomena may be associated with mental health problems. Moreover, the COVID-19 pandemic may elevate psychological distress and increase people's motivations to use the internet, which may promote addictive engagement.

Third, the present synthesized association evidence resonates with findings before the COVID-19 pandemic linking behavioral addictions (including behavioral addictions, related conditions, and phenomena) to mental health problems [32]. Internet-related behavioral addictions, related conditions, and phenomena may generate problems (e.g., loss of productivity) and further worsen mental health concerns [56]. However, cautions should be made because the associations found in the present study lacks evidence from longitudinal data, indicating the causality between behavioral addictions (including behavioral addictions, related

conditions, and phenomena) and mental health problems could not be concluded.

There are several limitations in the present systematic review and meta-analysis. First, the few publications of investigations of non-internet-related behavioral addictions, related conditions, and phenomena (e.g., eating or exercise addictions) during the COVID-19 pandemic limited analyses. Therefore, we could not firmly conclude that all types of behavioral addictions (including behavioral addictions, related conditions, and phenomena) are associated with mental health problems. Nevertheless, the synthesized evidence in the present systematic review and meta-analysis verified the associations between internet-related behavioral addictions (including behavioral addictions, related conditions, and phenomena) and many mental health problems. Second, the measures used to assess behavioral addictions (including behavioral addictions, related conditions, and phenomena) and mental health problems were diverse across the included studies, complicating comparability across studies. Although we acknowledge that this could be a potential issue for synthesis, we have used standard and state-of-the-art statistical methods (i.e., effect sizes based on Fisher's Z statistics) to investigate this topic. Therefore, we believe that this may not be a serious limitation. Third, most included studies used online surveys to collect data. Therefore, the sample representativeness could be concerning as there may be selection bias; for example, people without internet access during the survey period may have been under-represented or excluded.

Conclusion

In conclusion, the present systematic review and meta-analysis provides cumulated evidence regarding associations between specific types of behavioral addictions (including behavioral addictions, related conditions, and phenomena) and types of mental health problems during the COVID-19 pandemic. Most studies of behavioral addictions, related conditions, and phenomena focused on internet-related behaviors, with studies suggesting relationships with specific types of mental health problems during the COVID-19 pandemic. Moreover, associations between behavioral addictions (including behavioral addictions, related conditions, and phenomena) and mental health problems found in the present systematic review and meta-analysis were comparable to the associations identified in studies conducted before the COVID-19 pandemic. Nevertheless, data suggest that during the COVID-19 pandemic, many individuals experienced worse addictive behaviors and mental health problems. Therefore, how to help people reduce behavioral addictions (including behavioral addictions, related conditions, and phenomena) and address mental health problems are two important topics for healthcare providers.

Declarations

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•• Of major importance

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