

Problematic internet use during the COVID-19 pandemic: A systematic review and meta-analysis of prevalence data

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Aims: This study sought to synthesize prevalence rates of problematic internet use (PIU) during the COVID-19 pandemic in the general adult (age over 18 years old) population and to investigate its possible moderators. **Methods:** A preregistered systematic literature review using the PubMed/MEDLINE, EBSCOhost/PsycINFO, Web of Science, Cochrane Library, GSK Clinical Study Register, and ClinicalTrials.gov databases was conducted. Research was completed in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols 2015 checklist. **Results:** A total of 22 publications were identified, fulfilling inclusion criteria from a total of 595 studies. The analysis revealed that the prevalence of PIU during the COVID-19 pandemic period was 25%, however applying a stringent threshold for the PIU, resulted in a much lower prevalence of 7.9%. **Conclusion:** The PIU prevalence rate during the COVID-19 pandemic in the general population was 7.9%. Measuring the prevalence of PIU remains complicated due to the large methodological and cultural diversity that exists, so global prevalence estimates of PIU vary substantially. More methodologically sound research on psychodiagnostic assessment and cultural variances is required.

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INTRODUCTION

During the past decade, the internet has become an integral part of people's daily lives. It influences the accessibility of various services, as individuals can now access a variety of interactive experiences online due to its low cost and ease of use. The internet has extended existing technologies and given people greater flexibility in communication. However, for a number of vulnerable groups, internet use may become problematic due to its potentially addictive properties (e.g., accessibility, anonymity, convenience) and the online activities themselves (e.g., gaming, gambling, social media use) (Griffiths, 1995; Fineberg & Potenza, 2023).

The term problematic internet use (PIU) refers to behavioural addictions because internet use can result in dependence-like symptoms and can involve the consumption of psychoactive substances (Griffiths, 1995; Spada, 2014). PIU can involve a wide range of problematic online behaviours, such as excessive social media use, gaming, gambling, streaming, pornography viewing and impulsive purchasing as well as newer behaviours, such as cyberhoarding and cyberchondria (Fineberg et al., 2018; Vismara et al., 2022). Research on PIU has increased awareness of the potential negative effects of internet use on individuals' mental health (Fineberg et al., 2022), which has placed a significant burden on health systems worldwide in terms of the individual health and societal costs of PIU (WHO, 2015).

Over the past few years, there has been an increase in global internet usage due to the coronavirus disease 2019 (COVID-19) pandemic, as individuals have been forced to work or study from home as a result of measures taken to prevent the spread of the virus (e.g. lockdowns, quarantines, self-isolation). As pandemic-related circumstances led to an apparent increase in internet usage, experts expressed concern about the possibility of an increase in PIU, including problematic gaming, gambling and pornography use (Gjoneska et al., 2022; King et al., 2020; Király et al., 2020; Mestre-Bach et al., 2020). Because it is a behavioural addiction, it was feared that the prevalence of PIU could increase significantly during the pandemic, similar to substance use addictions and other behavioural addictions (Dores et al., 2021; Masaeli & Farhadi, 2021).

The COVID-19 pandemic has been regarded as a primary contributor to a variety of documented mental health problems, and it has been the primary factor in the apparent increase in the amount of time individuals have spent on the internet over the past

two years (e.g. increased depression, anxiety, stress, etc.) (Gecaite-Stonciene et al., 2021; Hampshire et al., 2021; Zhou et al., 2020). However, an increase in internet usage may not always have negative effects on mental health or the severity of PIU. There is evidence that the goal of and motivation for internet use are more influential for the psychological well-being and severity of PIU (Coyne et al., 2020) than the amount of time spent online. Therefore, the prevalence of PIU may not be directly related to the quantity of time spent online, but rather to the environment of PIU activity, particularly in gaming disorders (Király et al., 2017). Even so, the intensity of PIU may be associated with the severity of avoidant coping in response to real-life COVID-19 pandemic scenarios (Mota et al., 2021). In this context, it is anticipated that mental health issues (e.g. depression and anxiety) may serve mediate between the amount of time spent online and the severity of PIU.

A recent meta-analysis of 700,000 participants from 113 epidemiological studies in 31 countries revealed that 7.0% of the population may be affected by PIU (Pan et al., 2020). Similarly, the study by Cheng and Li (Cheng & Li, 2014) included data from 31 countries ($n = 89,281$) and revealed a PIU prevalence estimate of 6.0%. A meta-analysis of 1,818 healthcare workers showed a slightly higher PIU prevalence estimate of 9.7%, which indicates that certain professions may be more susceptible to PIU (Buneviciene & Bunevicius, 2021).

Estimates of the prevalence of PIU vary considerably between studies. Multiple studies that assessed the prevalence rates of PIU around the world were released in 2021 (the data in these studies were collected in 2019 – that is, pre-pandemic). Even when utilising the same screening instrument to evaluate PIU – most notably the Internet Addiction Test (IAT, cut score 50) – there is still a large variance in the prevalence estimates when evaluating research in greater depth. Guo et al. (Guo et al., 2021) conducted a study including 30,581 Chinese university students and estimated a PIU frequency of 8.4%. A Chinese study (Wang et al., 2021) of 1,956 adolescent school pupils estimated the frequency of PIU to be 14.5%. In a recent cross-sectional study conducted in Ethiopia (Mengistu et al., 2021), the estimated prevalence of PIU among 761 university students was found to be 19.4%. Dib et al. (Dib et al., 2021) observed a similar PIU estimate (20.7%) among 1,810 Lebanese teenagers attending a private school. In a Turkish survey of 1,558 high school students, the frequency of PIU was estimated to be 21.1% (Cam & Top, 2020). However,

one Indian study (Thirusangu et al., 2020) of 470 nursing students estimated the frequency to be 47.0%. All of these recent studies used the same instrument (Internet Addiction Test, IAT) and cut score (i.e. 50) but nevertheless yielded conflicting results, which could be partially due to methodological and cultural variances, as well as to the non-representativeness of the different types of cohorts sampled.

Similar to studies conducted before the COVID-19 pandemic, some inconsistencies have been observed in recently published systematic reviews and meta-analyses reporting the prevalence of PIU in the general public during the COVID-19 pandemic. In a study conducted by Shi-Qiu Meng et al. (Meng et al., 2022), internet addiction prevalence was reported at 8.23%, whereas Alimoradi et al. (Alimoradi et al., 2022) estimated internet addiction prevalence to be up to 10.6%. However, neither of these studies excluded children from the samples. We wanted to particularly look at the sample of young adults.

Due to the impact of the COVID-19 pandemic and apparent inconsistencies in the prevalence of PIU, it is necessary to re-examine PIU prevalence and potential moderators with a meta-analysis (Burkauskas et al., 2022). The purpose of this meta-analysis was thus to investigate prevalence rates of PIU in the general population (individuals recruited from the community or students/undergraduates) during the COVID-19 pandemic, as well as to investigate the potential moderators of these prevalence rates based on participants' age, gender and the countries where the study was conducted (Eastern vs Western).

METHODS

A protocol for the systematic review and meta-analysis was defined and registered online in the International Prospective Register of Systematic Reviews (PROSPERO, Register ID = CRD42021284619). This research was conducted in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) 2015 checklist tool (Moher, et al., 2009). A descriptive synthesis was implemented through text and tables to provide a summary, explanation of study characteristics and findings (Table 1).

Search Strategy

Published studies were found from March 2018 to November 2021 using the electronic databases PubMed/MEDLINE, EBSCOhost/PsycINFO, Web of

Science and the Cochrane Library. In addition, the GSK Clinical Study Register and unpublished relevant data in ClinicalTrials.gov were examined. The following keywords were used in the search: (“problematic internet use” OR “internet addiction” OR “excessive internet use” OR “internet use” OR “internet gaming disorder” OR “problematic use of internet” OR “problematic use of the internet”) AND (COVID-19 OR “2019 novel coronavirus” OR “2019-nCoV” OR “Coronavirus 19” OR “SARS-CoV-2”). Two reviewers (JB and JGS) independently assessed the chosen studies in light of the inclusion and exclusion criteria to assure validity. Authors made a consensus decision about any study for which potential inclusion was ambiguous.

Eligibility Criteria

The inclusion criteria used for this study were: (1) cross-sectional, case-control, longitudinal designs; (2) studies using self-report instruments, clinician-administered interviews or proxy-reported questionnaires to assess PIU; (3) studies reporting data necessary to calculate the prevalence rate of the PIU (sample size of the total sample and number of participants reporting the PIU); (4) studies investigating PIU as an independent condition according to criteria internationally recognised, such as those proposed by (Fineberg et al., 2018); (5) studies comprising data on prevalence rates of PIU during the COVID-19 pandemic; (6) peer-review journals; (6) participants ≥ 14 years old; and (7) articles written in English.

The study's exclusion criteria were as follows: (1) reviews, case series, opinion papers and anecdotal reports; (2) studies involving participants with psychiatric or any medical disorder implying physical disability; (3) studies on young individuals aged < 14 ; or (4) no restrictions in terms of population, as long as the study provided information relevant to our study aim.

Data Extraction and Management

Two independent reviewers (JB and JGS) retrieved all of the material from each of the included studies using the systematic review tool Rayyan (<https://www.rayyan.ai/>). The following information was extracted and coded from each of the included studies: (1) the title of the paper (2) the first author; (3) publication date; (4) country where the study was conducted (coded as Eastern vs Western countries); (5) inclusion

Table 1. Characteristics of selected studies

No	Reference	Country (data collection date)	Study Design	Study population	Sex (Female, n, %)	Age (age range or mean age ± SD)	PIU assessment tool and cut-off	Prevalence (n, %)
1	Y. Sun, Y. Li, Y. Bao, S. Meng, Y. Sun, G. Schumann, T. Kosten, J. Strang, L. Lu, J. Shi, Brief report: increased addictive internet and substance use behavior during the COVID-19 pandemic in China, <i>Am. J. Addict.</i> 29 (2020) 268–270. https://doi.org/10.1111/ajad.13066 . PMID: 32500608; PMCID: PMC7300868.	China (24–31 March 2020)	Cross-sectional	General population (6,416)	3,400 (53.0)	28.23 ± 9.23	IAT-20 ≥ 80	274 (4.3)
2	T. Oka, T. Hamamura, Y. Miyake, N. Kobayashi, M. Honjo, M. Kawato, T. Kubo, T. Chiba, Prevalence and risk factors of internet gaming disorder and problematic internet use before and during the COVID-19 pandemic: a large online survey of Japanese adults, <i>J. Psych. Res.</i> 142 (2021) 218–225. https://doi.org/10.1016/j.jpsychires.2021.07.054 . PMID: 34385071.	Japan (August 2020)	Cross-sectional Follow-up	General population adult (51,246)	25,674 (50.1)	46.6 ± 11.8	CIUS-14 ≥ 29	3997 (7.8)
3	K. Siste, E. Hanafi, L.T. Sen, H. Christian, Adrian, L.P. Siswidiani, A.P. Limawan, B.J. Murtani, C. Suwartono, The impact of physical distancing and associated factors towards internet addiction among adults in Indonesia during COVID-19 pandemic: a nationwide web-based study, <i>Frontiers Psych.</i> 11 (2020) 580977. https://doi.org/10.3389/fpsyg.2020.580977 . PMID: 33101092; PMCID: PMC7495250.	Indonesia (April–June 2020)	Cross-sectional	General population adults (4,734)	2,121 (44.8)	31.84 ± 7.73	KDAI ≥ 108	681 (14.4)
4	R. Truzoli, V. Pirola, L. Celebre, E. Piccoli, S. Vanzetto, D. Conti, F. Fasciana, G. Casazza, Intrapersonal and social factors for problematic internet use among students during the COVID-19 pandemic, <i>Psychiatria Danubina</i> , 33 (2021) 144–154. PMID: 34672289.	Italy (March 2020)	Cross-sectional	Students (191)	140 (73.3)	19.8 (7.1)	IAT-20 ≥ 40	60 (54.1)
5	Y.Y. Li, Y. Sun, S.Q. Meng, Y.P. Bao, J.L. Cheng, X.W. Chang, M.S. Ran, Y.K. Sun, T. Kosten, J. Strang, L. Lu, J. Shi, Internet addiction increases in the general population during COVID-19: evidence from China, <i>Am. J. Addict.</i> 30 (2021) 389–397. https://doi.org/10.1111/ajad.13156 PMID: 33738888; PMCID: PMC8251395.	China (March–April 2020)	Cross-sectional	General population (20,472)	11,567 (56.5)	33.63 ± 9.53	IAT-20 ≥ 50	7513 (36.7)
6	X. Xie, K. Zhu, Q. Xue, Y. Zhou, Q. Liu, H. Wu, Z. Wan, J. Zhang, H. Meng, B. Zhu, R. Song, Problematic internet use was associated with psychological problems among university students during COVID-19 outbreak in China, <i>Frontiers Public Health</i> 9 (2021) 675380. https://doi.org/10.3389/fpubh.2021.675380 . PMID: 34211954; PMCID: PMC8239128.	China (April 2020)	Cross-sectional	Students (8879)	4830 (54.4)	21.27 ± 2.39	YDQ-8 5 “yes” out of 8	2521 (28.4)
7	W.M. Shehata, D.E. Abdeldaim, Internet addiction among medical and non-medical students during COVID-19 pandemic, <i>Tanta University, Egypt, Environ. Sci. Pollution Res. Int.</i> 28 (2021) 59945–59952. https://doi.org/10.1007/s11356-021-14961-9 . PMID: 34148197; PMCID: PMC8214711.	Egypt (October–November 2020)	Cross-sectional	Students (746)	501 (67.2)	No data	a) IAT-20 ≥ 50 b) IAT-20 ≥ 80	a) 654 (87.67) b) 235 (31.67)
8	M.J. Tahir, N.I. Malik, I. Ullah, H.R. Khan, S. Perveen, R. Ramalho, A.R. Siddiqi, S. Waheed, M.M.M. Shalaby, D. De Berardis, S. Jain, G.L. Vetrivendan, H. Chatterjee, W.X. Gopar Franco, M.A. Shafig, N.T. Fatima, M. Abeysakera, Q. Sayyeda, S.F. Shamat, W. Aiman, ... A.H. Pakpour, Internet addiction and sleep quality among medical students during the COVID-19 pandemic: a multinational cross-sectional survey, <i>PLoS one</i> 16 (2021) e0259594. https://doi.org/10.1371/journal.pone.0259594 . PMID: 34739502; PMCID: PMC8570473.	Dominican Republic, Egypt, Guyana, India, Mexico, Pakistan, Sudan, (June–July 2020)	Cross-sectional	General population but mostly students (2,749)	1,758 (64.0)	15–44	a) IAT-20 ≥ 50 b) IAT-20 ≥ 80	a) 760 (27.64) b) 60 (2.2)
9	S.Y. Meitei, P.S.V. Pao, K.D. Baite, H. Konjengbam, Prevalence of insomnia and internet dependence amidst the COVID-19 among the Northeast Indian Population: a preliminary study, <i>Sleep Vigilance</i> 5 (2021) 245–250. https://doi.org/10.1007/s41782-021-00153-5 . PMID: 34308100; PMCID: PMC8288417.	India, (May–June 2020)	Cross-sectional	General population (585)	263 (44.96)	18–50	YDQ-8 5 “yes” out of 8	167 (28.55)
10	G. Ballarotto, E. Marzilli, L. Cerniglia, S. Cimino, R. Tambelli, How does psychological distress due to the COVID-19 pandemic impact on internet addiction and Instagram addiction in emerging adults? <i>Int. J. Environ. Res. Public Health</i> 18 (2021) 11382. https://doi.org/10.3390/ijerph182111382 . PMID: 34769897; PMCID: PMC8583668.	Italy, (November 2020–March 2021)	Cross-sectional	General population but mostly students (400)	280 (70)	18–25	IAT-20 ≥ 70	46 (11.5)
11	M. Forster, C.J. Rogers, S. Sussman, J. Watts, T. Rahman, S. Yu, S.M. Benjamin, Can adverse childhood experiences heighten risk for problematic internet and smartphone use? Findings from a college sample, <i>Int. J. Environ. Res. Public Health</i> 18 (2021) 5978. https://doi.org/10.3390/ijerph18115978 . PMID: 34199554; PMCID: PMC8199656.	USA (October–December 2020)	Cross-sectional	Students (1,027)	804 (78.32)	17–30+	a) IAT-20 ≥ 50 b) IAT-20 ≥ 80	a) 89 (8.69) b) 13 (1.27)
12	M. Mohler-Kuo, S. Dzemaili, S. Foster, L. Werlen, S. Walitza, Stress and mental health among children/adolescents, their parents, and young adults during the first COVID-19 lockdown in Switzerland, <i>Int. J. Environ. Res. Public Health</i> 18 (2021) 4668. https://doi.org/10.3390/ijerph18094668 . PMID: 33925743; PMCID: PMC8124779.	Switzerland (July–September 2020)	Cross-sectional	Nationally representative sample (1,627)	983 (60.4)	21.5 ± 1.7	CIUS-SF ≥ 80	(21.3)
13	A. Zalewska, M. Galczyk, M. Sobolewski, I. Bialokoz-Kalinowska, Depression as compared to level of physical activity and internet addiction among Polish physiotherapy students during the COVID-19 pandemic, <i>Int. J. Environ. Res. Public Health</i> 18 (2021) 10072. https://doi.org/10.3390/ijerph181910072 . PMID: 34639374; PMCID: PMC8507809.	Poland (November 2020)	Cross-sectional	Students (141)	104 (73.76)	18–25	IAT-20 ≥ 50	11 (7.8)
14	H. Cai, H.T. Xi, Q. Zhu, Z. Wang, L. Han, S. Liu, W. Bai, Y.J. Zhao, L. Chen, Z.N. Ge, M. Ji, H. Zhang, B.X. Yang, P. Chen, T. Cheung, G.S. Ungvari, F. An, Y.T. Xiang, Prevalence of problematic internet use and its association with quality of life among undergraduate nursing students in the later stage of COVID-19 pandemic era in China, <i>Am. J. Addicts.</i> 30 (2021) 585–592. https://doi.org/10.1111/ajad.13216 . PMID: 34532935; PMCID: PMC8652965.	China (September–October 2020)	Cross-sectional	Nursing students (1,070)	805 (75.2)	19.7 ± 1.4	IAT-20 ≥ 50	(23.3)
15	Y. Xia, Y. Fan, T.H. Liu, Z. Ma, Problematic internet use among residential college students during the COVID-19 lockdown: a social network analysis approach, <i>J. Behav. Addict.</i> 10 (2021) 253–262. https://doi.org/10.1556/2006.2021.00028 . PMID: 34019485.	China (July–September 2020)	Cross-sectional	University students (494)	353 (71.5)	19.69 ± 1.30	YDQ-8 5 “yes” out of 8	151 (30.6)

No	Reference	Country (data collection date)	Study Design	Study population	Sex (Female, n, %)	Age (age range or mean age ± SD)	PIU assessment tool and cut-off	Prevalence (n, %)
16	Y. Zhao, Z. Jiang, S. Guo, P. Wu, Q. Lu, Y. Xu, L. Liu, S. Su, L. Shi, J. Que, Y. Sun, Y. Sun, J. Deng, S. Meng, W. Yan, K. Yuan, Z. Sun, L. Yang, M. Ran, T.R. Kosten, ... J. Shi, Association of symptoms of attention deficit and hyperactivity with problematic internet use among university students in Wuhan, China during the COVID-19 pandemic. <i>J. Affect. Disord.</i> 286 (2021) 220–227. https://doi.org/10.1016/j.jad.2021.02.078 . PMID: 33740639.	China (June–July 2020)	Cross-sectional	University students (11,254)	7,200 (64.0)	20.0 ± 1.3	IAT-20 ≥ 50	3191 (28.4)
17	J.-M. Romero-Rodríguez, J.-A. Marín-Marín, F.-J. Hinojo-Lucena, G. Gómez-García, An explanatory model of problematic internet use of southern Spanish university students. <i>Soc. Sci. Comp. Rev.</i> 40 (2021) 1171–1185. https://doi.org/10.1177/0894439321998650 .	Spain (February 2020)	Cross-sectional	University students (1,013)	761 (71.1)	22.2 ± 3.9	a) IAT-20 ≥ 50 b) IAT-20 ≥ 80	a) 126 (12.4) b) 1 (0.1)
18	A. Sayeed, M.H. Rahman, M.N. Hassan, E. Christopher, S. Kundu, M.H. Al Banna, A.R. Hasan, T. Mallick, A.E. Meem, M.T. Hasan, Problematic internet use associated with depression, health, and internet-use behaviors among University students of Bangladesh: a cross-sectional study. <i>Child. Youth Serv. Rev.</i> 120 (2021) 105771.	Bangladesh (February–March 2020)	Cross-sectional	University students (404)	199 (49.3)	21.03 ± 1.94	IAT-20 ≥ 50	177 (43.8)
19	G. Tóth, K. Kapus, D. Hesszenberger, M. Pohl, G. Kósa, J. Kiss, G. Pusch, É. Fejes, A. Tibold, G. Feher, Prevalence and risk factors of internet addiction among Hungarian high school teachers. <i>Life</i> 11 (2021) 194. https://doi.org/10.3390/life11030194 .	Hungary (January–August 2020)	Cross-sectional	High school teachers (1,817)	1,194 (65.7)	18–65	PIUQ-18 ≥ 42	95 (5.2)
20	G. Toth, K. Kapus, D. Hesszenberger, M. Pohl, G. Kosa, J. Kiss, G. Pusch, E. Fejes, A. Tibold, G. Feher, Internet addiction and burnout in a single hospital: is there any association? <i>Int. J. Environ. Res. Public Health</i> 18 (2021) 615. https://doi.org/10.3390/ijerph18020615 .	Hungary (January–August 2020)	Cross-sectional	Single hospital staff (485)	411 (84.8)	18–65	PIUQ-18 ≥ 42	19 (3.9)
21	I.B. Condori-Meza, L.A. Dávila-Cabanillas, M.R. Challapa-Mamani, A. Pinedo-Soria, R.R. Torres, J. Yalle, R. Rojas-Humpire, S. Huanchuire-Vega, Problematic internet use associated with symptomatic dry eye disease in medical students from Peru. <i>Clin. Ophthalmol.</i> 15 (2021) 4357–4365. https://doi.org/10.2147/OPHTH.S334156 . PMID: 34744432; PMCID: PMC8565988.	Peru (December–February 2021)	Cross-sectional	Students (844)	543 (64.3)	21.8 ± 3.3	IAT-20 ≥ 50	124 (14.7)
22	I. Jahan, I. Hosen, F. Al Mamun, M.M. Kaggwa, M.D. Griffiths, M.A. Mamun, How has the COVID-19 pandemic impacted internet use behaviors and facilitated problematic internet use? A Bangladeshi study. <i>Psychol. Res. Behav. Manag.</i> 14 (2021) 1127–1138. https://doi.org/10.2147/PRBM.S323570 . PMID: 34345189; PMCID: PMC8324976.	Bangladesh (October–November 2020)	Cross-sectional	Students (601)	257 (42.8)	17–25	a) IAT-20 ≥ 50 b) IAT-20 ≥ 80	a) 295 (49.1) b) 24 (4)

Note: IAT-20, 20-item Internet Addiction Test; CIUS-14, 14-item Compulsive Internet Use Scale; CIUS-SF, Compulsive Internet Use Scale – Short Form; KDAI, Internet Addiction Diagnostic Questionnaire; YDQ-8, 8-item Young Diagnostic Questionnaire; PIUQ-18, 18-item Problematic Internet Use Questionnaire.

and exclusion criteria; (6) total sample size; (7) mean age of the total sample in the study; (8) percentage of females in the total sample in the study; (9) research design; (10) number of participants reporting PIU; (11) questionnaire used to assess the PIU; (12) type of population from which the study sample was drawn (general population, undergraduates, high-school students, clinical sample with a psychiatric disorder); and (13) strategies used to recruit individuals. Uninvolved in the extraction procedure, an independent reviewer (LP) checked the accuracy of the data and coding put into the spreadsheet created by the systematic review tool. After the data were entered, discrepancies in the data gathered by the two reviewers were discussed in a staff meeting with the reviewer who checked the procedure. Following the PRISMA guidelines, a flowchart demonstrating the different phases of the selection process was created and is shown in Figure 1 (Moher et al., 2009).

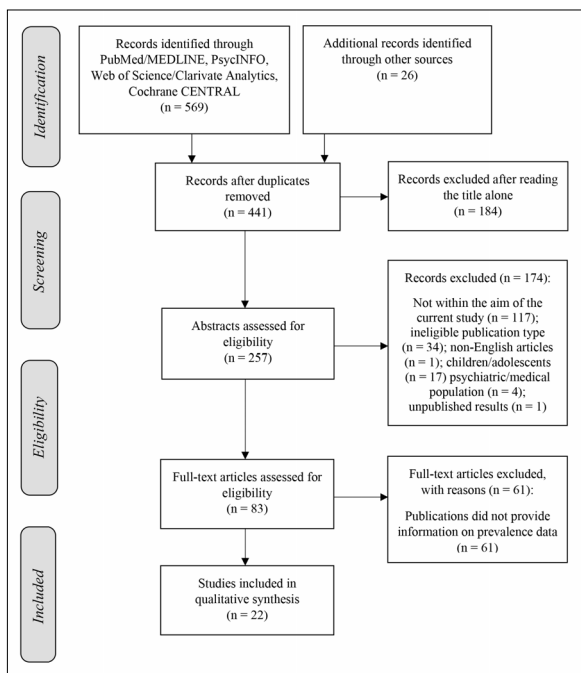
Risk of Bias (Quality) Assessment

Critical appraisal was conducted by two independent reviewers (KM and JGS) using the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for analytical cross-sectional studies (Munn Z. et al., 2020).

Statistical Analysis

A systematic analytical approach was used to compute the pooled PIU prevalence rates from all eligible studies. JASP software was used to perform meta-analyses of proportions, derive pooled estimates, obtain exact binomial confidence intervals, and produce forest plots. The pooled estimates were calculated after the Freeman–Tukey Double Arcsine Transformation (Freeman & Tukey, 1950) to stabilise the variances. A random-effects model was selected to summarise the prevalence of PIU, using proportions and 95% confidence intervals (CIs).

Figure 1. PRISMA 2009 flow chart of study selection



Query: (“problematic internet use*” OR “internet addiction” OR “excessive internet use*” OR “internet use*” OR “internet gaming disorder” OR “problematic use* of internet” OR “problematic use* of the internet”) AND (COVID-19 OR “2019 novel coronavirus” OR “2019-nCoV” OR “Coronavirus 19” OR “SARS-CoV-2”)
 Note: Copyright: © 2009 Moher et al. Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred reporting items for systematic reviews and metaanalyses: the PRISMA statement. PLoS Med 6(7):e1000097.
<https://doi.org/10.1371/journal.pmed.1000097>

In the context of prevalence assessment, our methodology closely mirrors that employed by Meng et al. (2022) in their recent meta-analysis. Some studies utilized the IAT and presented two distinct thresholds for delineating addictive internet use, namely IAT > 50 or IAT > 70. Consistent with the original version of the IAT (Young, 2016), Meng et al (2022) used these two thresholds to respectively delineate the spectrum of ‘moderate’ and ‘severe’ addiction. The lower threshold (IAT>50) corresponds more closely with the comparatively similar thresholds used in other instruments for capturing PIU. Consequently, where studies presented two different IAT thresholds, for our initial analysis encompassing all studies and scales we opted to use the frequency related to the lower threshold i.e. IAT > 50 to delineate PIU. However, in the supplementary analysis, which explores a more stringent criterion for delineating a more severe and

Figure 2. Forest plot of all of the studies included in the analysis

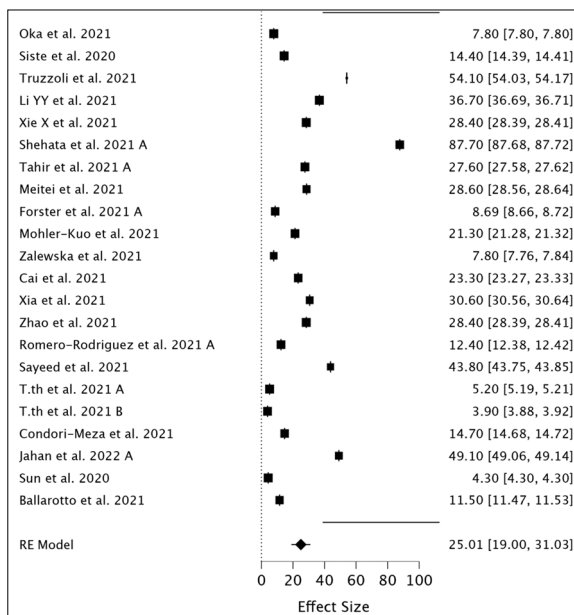
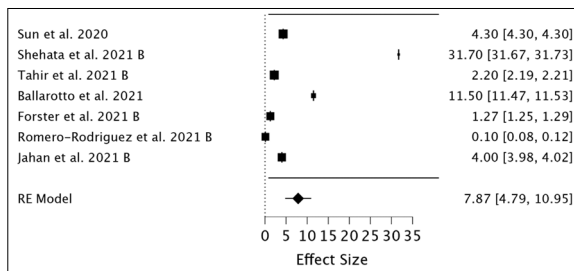


Figure 3. Forest plot of the studies using a cut-off score above 70 on the Internet Addiction Test



putatively ‘clinically relevant’ form of PIU, we chose the frequency relating to the higher 70-point IAT threshold.

Subgroup analyses were performed to investigate heterogeneity. The analyses were conducted based on the Der Simonian and Laird method (DerSimonian & Laird, 1986). We used the method of moments to estimate the additive (between-studies) component of variance τ . The significance level was set at $p < 0.05$. All statistical analyses were performed using JASP, version 0.10.1, an open-source statistical software developed by the University of Amsterdam.

RESULTS

The pooled prevalence rate of PIU in the studies was 25%, with a CI of 19.00–31.03. We also ran subgroup analyses for age, gender, and geographical location

of the studies, but we did not find any significant results. Heterogeneity between the studies remained high ($I^2=100\%$).

Interestingly, we ran a subgroup analysis using only the studies that adopted the IAT scale and used a cut-off score above 70 on the IAT. The pooled prevalence rate of PIU in those studies was significantly lower, 7.87% ($p<0.05$), than the studies adopting a lower threshold. This finding could point to the difference between the pooled prevalence rate of clinically significant PIU and the pooled prevalence rate of PIU that is not clinically significant. Many of the scales used in the studies we included do not pick up clinically significant PIU, but only the presence of PIU, which could be a behaviour that does not cause major impairment. A threshold of 70 on the IAT means that those studies included individuals who are impaired by PIU and therefore might manifest a clinical symptomatology of behavioural addiction. This difference also points to the importance of the instrument used to measure PIU and the threshold adopted; in the studies we included, a variety of measurements were used with different cut-off points, contributing to the high heterogeneity among studies.

DISCUSSION

This systematic review and meta-analysis looked at 22 research articles on PIU in the general population during the COVID-19 pandemic, as well as investigated potential moderators of the prevalence rates based on the participants' age, gender and the countries where the study was conducted. The findings yielded an estimate of 25% for the total prevalence of PIU during the epidemic. In addition, PIU scores across the studies ranged from 0.1% to 87.67% depending on cultural differences as well as the psychometric properties of various assents tools used. In contrast, recent meta-analyses published by Meng et al. (Meng et al., 2022) and Alimoradi et al. (Alimoradi et al., 2022) found PIU prevalence rates of 14.22% and 10.6%, respectively. However, given the time period, we managed to find and include more articles on PIU in adults than did Meng et al. (Meng et al., 2022).

Social, cultural, and demographic variables in internet access, usage and attitudes may account for the discrepancies in PIU prevalence estimates. It is well-known that the propensity to use the internet in European nations fluctuates over time (Oesterreich, 2020). However, more research on cultural variations

and PIU's characteristics in relation to prevalence estimations is advised (Fineberg et al., 2018).

Variations in PIU prevalence were also greatly influenced by the screening tools employed. Using the Compulsive Internet Use Scale (CIUS), the study by Oka et al. (Oka et al., 2021) in Japan estimated the prevalence of PIU to be 8% (cut-off score of 29). In contrast, Romero-Rodríguez et al. (Romero-Rodríguez et al., 2022) found a prevalence estimate of 12% (IAT, cut score > 50) among 1,013 university students in Spain. A Chinese cross-sectional study of 11,254 university students by Zhao et al. (Zhao et al., 2021) estimated the PIU prevalence rate to be 28.4%. Guo et al. (Guo et al., 2021) and Wang et al. (Wang et al., 2021) gathered data in 2019 and estimated prevalence of PIU in university students as 8.4% and 14.5% in adolescents. All three of these studies evaluated PIU using the IAT, with a cut-off score less than 50. However, both (Guo et al., 2021) and (Wang et al., 2021) recruited study participants using a multistage, random selection approach, but (Zhao et al., 2021) employed an online convenience sampling method, which may explain the discrepancy in the results. In addition, possible lockdown limits may also have contributed to the increase in prevalence. The two studies that were conducted in China during 2020 with a similar population sample of university students also reported 23.3% and 28.4% PIU prevalence estimations, which shows a 5.1% difference in prevalence rate (Cai et al., 2021; Zhao et al., 2021).

When reviewing the results, differences were found among the overall rate of PIU obtained by including the 22 studies explored in this meta-analysis and the different scales with different cut-off score criteria (first forest plot) in comparison to the study by Ballarotto et al. (Ballarotto et al., 2021) with a cut score > 70 in the IAT (third forest plot), which showed a drop in prevalence from 17% to 4%. This may lead to a gap in the literature regarding the reliability of the subcategories of the tool utilized for more accurate representation of the severity of symptomatology. There are limited studies on this phenomenon that can be further explored in epidemiological level research, which could help to better understand and reflect the prevalence of PIU in the general population.

Some European estimates of PIU prevalence during the COVID-19 pandemic were comparable to Asian ones, while others were lower. Using the Problematic Internet Use Questionnaire (with a cut score of 42), two Hungarian studies determined the prevalence rates of PIU to be 3.9% and 5.2% (Tóth et al., 2021;

Tóth et al., 2021). A Swiss study by Mohler-Kuo et al. (Mohler-Kuo et al., 2021) utilizing data from 1,627 young adults and 1,146 children and adolescents estimated the PIU prevalence rate to be 21.3% for young adults and 30.1% for children and adolescents (CIUS-Short Form, cut score of 13).

In addition, the analysed publications relied on self-report screening methods, which have been shown to increase prevalence estimates for unusual conditions (Maraz et al., 2015). Regarding variations in PIU prevalence, it is also essential to highlight that most studies utilized convenience samples. Convenience sampling is valid for descriptive research and explorations of potential links but not for uncertainty measures such as confidence intervals around prevalence values (Pierce et al., 2020). Consequently, caution must be exercised when comparing prevalence estimates resulting from diverse sampling methods.

The present meta-analysis and systematic review has several limitations. The research was limited to a small number of English language, peer-reviewed, indexed studies that measured the prevalence of PIU among the general population during COVID-19 pandemic. While the search approach reduced the possibility of publication bias, it is possible that some studies and important work were overlooked. In addition, some of the research analysed lacked representative samples. Consequently, the estimated prevalence reported in this systematic review and meta-analysis may not be applicable to the entire global population. In addition, most of the research used online surveys to collect data, which may have led to sample bias. Specifically, respondents without internet access or who did not use the internet during the survey period were unable to complete the surveys. Due to the exclusion of non-internet users from the current study, it is probable that estimates of PIU were affected. In addition, all of the studies analysed in this systematic review and meta-analysis utilized a cross-sectional design, which precludes the establishment of causal relationships between the research variables. Various instruments were used to measure PIU in the reviewed literature.

In conclusion, the current review and meta-analysis of existing research on PIU in the general population during the COVID-19 pandemic indicated a prevalence of 7.9%. Because the psychological effects of the COVID-19 pandemic have been thoroughly documented in the scientific literature, there is little doubt that the pandemic affected the mental health of millions of people. The

measurement of PIU prevalence is still complex, because of the significant methodological and cultural variability that exists. As a result, estimates of PIU prevalence vary greatly around the globe. There is thus need for more methodologically sound research on the psychodiagnostic assessment and cultural variations.

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LIST OF ABBREVIATIONS

CIUS: Compulsive Internet Use Scale

COVID-19: coronavirus disease 2019

IAT: Internet Addiction Test

PIU: problematic internet use

PRISMA-P: Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols

PROSPERO: International Prospective Register of Systematic Reviews

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Problémás internethasználat a COVID-19 pandémia alatt: szisztematikus review és a prevalenciaadatok metaanalízise

Célkitűzés: A tanulmány célja az volt, hogy szintetizálja a problémás internethasználat (PIU) előfordulási gyakoriságait a COVID-19 világjárvány alatt az felnőtt (18 év feletti) lakosság körében, és megvizsgálja annak lehetséges befolyásoló tényezőit. **Módszerek:** Előregisztrált szisztematikus szakirodalmi áttekintést végeztünk a PubMed/MEDLINE, EBSCOhost/ PsycINFO, Web of Science, Cochrane Library, GSK Clinical Study Register és ClinicalTrials.gov adatbázisok segítségével. A kutatás a 2015. évi PRISMA ellenőrzőlista alapján zajlott. **Eredmények:** Az összesen 595 tanulmányból 22 olyan publikációt azonosítottunk, amelyek teljesítették a beválasztási kritériumokat. Az elemzés feltárta, hogy a PIU prevalenciája a COVID-19 világjárvány időszakában 25% volt, azonban szigorú küszöbérték alkalmazása a PIU-ra jóval alacsonyabb, 7,9%-os prevalenciát eredményezett. **Következtetés:** A PIU előfordulási aránya a COVID-19 világjárvány idején az általános népességben 7,9% volt. A PIU prevalenciájának mérése továbbra is bonyolult a jelentős mértékű módszertani és kulturális sokféleség miatt, így a PIU globális prevalencia becslései jelentősen eltérnek. A pszichodiagnosztikai vizsgálat és a kulturális eltérések módszertanilag megalapozottabb kutatására van szükség.

Kulcsszavak: COVID-19; internetfüggőség, problémás internethasználat, prevalencia, szisztematikus áttekintés, metaanalízis

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