



Association between internet addiction and loneliness across the world: A meta-analysis and systematic review

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ABSTRACT

There might be an association between Internet addiction (IA) and loneliness; however, inconsistent evidence suggests that the severity of this association remains unclear. This study was conducted to assess the association between IA and loneliness. A systematic literature search was conducted in four online databases, including PubMed (MESH terms), Web of Science, Scopus, and Embase. Observational studies measuring the association between IA and loneliness were screened and included in this review. A meta-analysis was conducted using the Stata software. Twenty-six articles with a total sample size of 16496 subjects were included in the analysis. A moderate positive association ($r = 0.15$ (95% CI: 0.13, 0.16)) was found between IA and loneliness. The individuals with IA had significantly higher scores of loneliness. According to this meta-analysis, we need more attention to the early symptoms of loneliness in individuals with IA. Longitudinal studies are needed to determine the temporality of this association considering adjustment for time varying confounders.

1. Introduction

Internet use, as a vital tool for information sharing, has increased significantly over the last 50 years with a growth rate of 305.5% in the last decade worldwide (Iacovelli & Valenti, 2009; Odacı & Çelik, 2013). Moderate internet use can be helpful and make our lives easier; however, excessive, uncontrolled use has negative consequences (Shi et al., 2017). The available literature suggests that using the internet for 5 h or more per day is considered problematic (Odacı & Kalkan, 2010). Excessive use of the internet has been described as internet addiction (IA), pathological use of the internet, internet dependency, and problematic internet use (PIU) (Odacı & Çelik, 2013). IA is defined as inability to control the internet use that eventually leads to impaired psychological functioning, emotions, interpersonal relationships, and academic performance (Li et al., 2016). In addition, PIU is defined as psychological, work, school, and social life problems that result from inadequate control over the internet use (Odacı & Çelik, 2013). According to previous studies, the global prevalence of IA in 2014 is 6% in the age group 12–41 years (Lau et al., 2017). Loneliness is described as an undesirable and unpleasant experience that is almost always

accompanied by anxiety, anger, sadness, and feelings. Although it is usually more severe in teenagers and young adults, it may exist in any period of life. Lonely individuals usually separate themselves from time situations, personal and public responsibilities, associations, and social communication (Ümmet & Ekşi, 2016). Several studies have shown an association between internet use and loneliness. In other words, people with more internet use experience higher levels of loneliness compared to low and moderate users (Esen et al., 2013). However, these findings are inconsistent and suggest a positive or negative association between IA and loneliness (Odacı & Kalkan, 2010). These controversies of the results could be attributed to some reasons such as the methodology of studies, the definition of IA or PIU and loneliness, and the population of the study. In an effort to resolve these controversies, we conducted a qualitative meta-analysis on the association between IA and loneliness to evaluate the summary measure of this association and fill this gap.

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2. Methods

2.1. Protocol design

We used a systematic review and meta-analysis design to summarize observational studies published until August 2019. This study was performed in accordance with the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocol (PRISMA-P).

2.2. Search strategy

A comprehensive search was performed in several electronic databases including PubMed (MESH terms), Web of Science, Scopus, and Embase to identify all potentially relevant publications in English language until August 2019. The detailed search strategy for PubMed was as follows: ("Internet addiction"[Title/Abstract] OR "problematic Internet use"[Title/Abstract] OR "Internet addiction disorder"[Title/Abstract] OR "pathological Internet use"[Title/Abstract] OR "Internet game addiction"[Title/Abstract] OR "excessive Internet use"[Title/Abstract] OR "compulsive Internet use"[Title/Abstract] OR "Internet dependency"[Title/Abstract] OR "computer addiction"[Title/Abstract]) AND ("loneliness"[Title/Abstract] OR "soleness"[Title/Abstract] OR "singleness"[Title/Abstract] OR "solitude"[Title/Abstract]). In addition, a backward search (bibliographic mining of identified papers for any additional studies) was conducted to identify any studies that were not retrieved in the main search strategy.

2.3. Inclusion criteria

All quantitative and qualitative studies published in English that evaluated the association of IA and loneliness and original studies published in English that evaluated the association of loneliness and problematic Internet use were included in this systematic review and meta-analysis.

2.4. Exclusion criteria

Letters to the editor, case reports, intervention studies, review studies and meta-analyses, seminars, and conference papers were excluded from this study. Moreover, articles with no specific definition for IA or loneliness were also excluded. Finally, two authors carefully examined the full-texts of the included articles.

2.5. Data collection and analysis

Two authors (FKH and HMS) screened the titles and abstracts of all studies to identify those that met the inclusion criteria. The studies were selected independently and the results were discussed to make the final selection. The final decision for each study was made after reading the full texts of all potentially eligible articles. In cases of disagreement, a third author was consulted.

2.6. Data extraction

A structured data collection form was used to extract the data from the papers. The extracted data included study characteristics (e.g. study design, publication year, outcome definition, and sample size) as well as motivators and barriers to physical activity. Data extraction was done by the same authors (FKH and HMS) who selected the studies independently. All disagreements were discussed with a third reviewer if necessary.

2.7. Evaluating the quality of articles

The quality of the studies was assessed using the Newcastle - Ottawa quality assessment scale (NOS) adapted for observational studies (Wells

et al., 2000). The NOS is based on three domains including the selection of study groups, comparability of groups and description of exposure and outcome. This scale, which includes eight items and star scores, assesses the quality of each study in each domain. All items except comparability domain have one star (the maximum score based on stars is two for the comparability domain). Totally, the earned stars are calculated as the total quality score for each study. Based on these criteria, study quality was rated on a scale from one star indicating very poor to 10 stars indicating high quality. Studies were categorized as high (8–10), moderate (6–7) or low quality (<6). Two authors (FKH and HMS) completed quality assessment independently. If there were disagreements or items that remained unclear, a third author was consulted.

2.7.1. Statistical analysis

For each study, the reported measure of association was converted to Cohen's *d* to estimate the association between IA and loneliness. In addition, for sensitivity analysis, subgroup analysis was performed based on the reported measure of association as odds ratio, Pearson's correlation coefficient, and beta coefficient. Statistical heterogeneity was checked using forest plots and I^2 .

Publication bias can result in an overestimate or underestimate in the results and finally failed the validity of the conclusions of meta-analyses and systematic reviews. In this case, we used the Funnel plot and trim-and-fill methods. A funnel plot and trim and fill method were used to assess potential publication bias. Subgroup analysis was carried out according to the types of measures of association. Sensitivity analysis was conducted by repeating the analysis after excluding each study. In meta-analysis section, we included 16 articles in analysis that 8 of them reported beta coefficient as effect measure, 4 of them odds ratio and 4 R correlation. Based on meta-analysis text book (Borenstein et al., 2021), with regarding to the numbers of articles, we used appropriate formula for converting all measures to a unit measure. In randomized clinical trial, we can combine the different estimates in a meta-analysis since the effect size has the same meaning in all studies. However, in observational studies the effect measures may be substantially different for different studies. Moreover, even if there is no technical barrier to converting the effect measures in observational studies to a common metric, it may be a bad idea. Nevertheless, as a sensitivity analysis, we used the mechanism in Supplementary Fig. 6 and related formula for incorporating multiple kinds of data and converting the effect measures to a common metric. The analyses were performed using the Stata software version 14.

3. Results

3.1. Study characteristics

The search strategy and the study selection algorithm are shown in Fig. 1. A total of 606 studies were identified according to the keywords and MeSH terms. Subsequently, after identifying relevant studies and removing duplicates and considering the inclusion and exclusion criteria, 190, 23, and 47 studies were excluded after reviewing their titles, abstracts, and full-texts, respectively. Finally, 26 relevant studies were assessed in terms of quality and included in the systematic review and 16 studies included in meta-analysis. Table 1 summarizes the characteristics of the selected studies.

3.2. Eligible papers

Of 26 studies, 24 were cross-sectional and 2 were cohort studies. Eleven studies were conducted in Turkey, 4 in China, 2 in USA, and 2 in Korea; the rest of studies were performed in Hong Kong, Kosovo, Pakistan, Italy, Greece, Australia, and Hungary. The sample size varied in different studies, with the smallest and largest sample size including 74 and 13588 individuals, respectively. Most of the studies had a sample

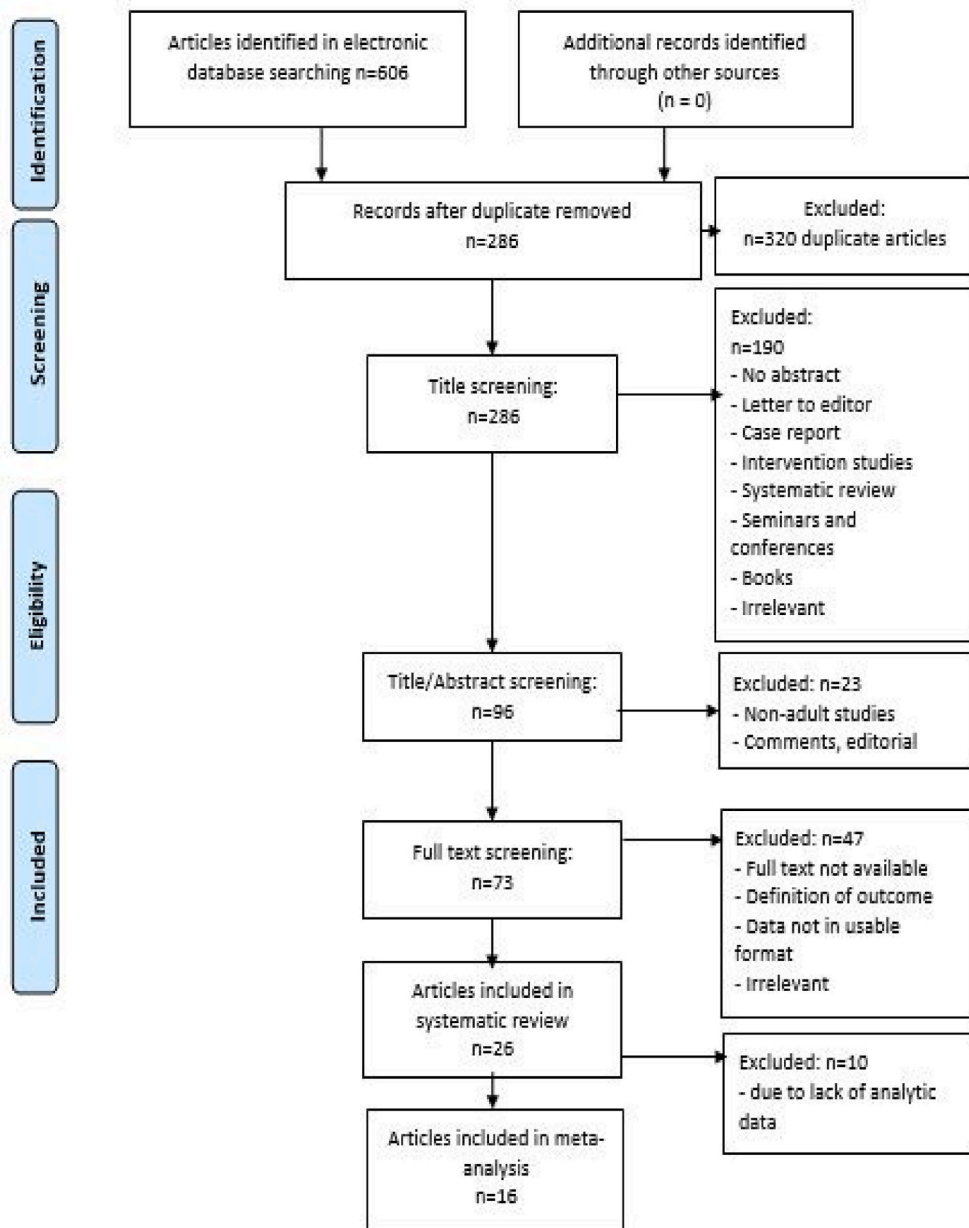


Fig. 1. Flow chart depicting the study selection process (screening).

size of below 1000 subjects.

Totally, in data extraction and quality assessment, there were disagreements about including 2 articles that finally one of them was exclude the other discussed with the third reviewer for quality assessment.

3.3. Quality assessment

A cut-off score of 6 or higher was considered as high quality. The majority of the studies received 6–8 scores (20 studies) indicating high quality. Six studies received 4–5 scores, indicating moderate quality.

3.4. Loneliness and internet addiction

Overall, there were 19 studies that assessed the association between IA and loneliness (Table 1). Of these, 17 were cross-sectional and 2 prospective. Of 19 cross-sectional studies, 15 studies reported the effect measures that 13 of them found increased loneliness among individuals

with IA compared with those with normal internet use. Of 2 prospective studies, one study found increased loneliness among individuals with IA and the other study a protective association between IA and loneliness.

3.5. Loneliness and problematic internet use (PIU)

Overall, there were 7 studies that assessed the association between PIU and loneliness (Table 1). All these 7 studies used cross-sectional design. Of 7 studies, 6 studies reported the effect measures that 4 of them found increased loneliness among individuals with PIU compared with those with normal internet use. Of 2 prospective.

3.6. Meta-analysis of the association between internet addiction and loneliness

Due to the limited number of the studies that evaluated the association between PIU and loneliness, all PIU studies were considered as IA in the meta-analysis section. According to the results, there was a

Table 1
Characteristics of eligible studies for systematic review (SR) and meta-analysis (MA).

Row	First author	Country and year of publish	Study design	Age of participants	Sample size	exposure	outcome	Effect measure	Effect size	Quality	Final analysis (SR or MA)
1	Wendi Li	China 2016	Cross-sectional	between 19 and 33 years	146	Loneliness (UCLA loneliness scale)	Internet addition	Beta coefficients of Hierarchical regression analysis,	Beta: 0.333 among non-ADHD group, Beta: 0.219 among adult with ADHD, p: 0.017	7	SR and MA
2	Joseph T.F. Laua	Hong Kong 2017	prospective		1545 students	Loneliness (UCLA(Chen Internet Addiction Scale))	Internet addition	Odds ratio of logistic regression	adjusted by baseline CIAS score and all socio-demographic backgrounds: OR: 0.93 (0.90,0.95)	8	SR and MA
3	Anthony Iacovelli	USA 2009	Cross-sectional	undergraduate female students	74	Loneliness	Internet addition	T-test	t(35) = -2.378, p = .023	6	SR
4	Scott Caplan	USA 2009	Cross-sectional	play MMO games	4000 MMO players	Loneliness (UCLA Loneliness Scale)	Problematic Internet use	Beta coefficients	Beta: .323, t: 21.37	7	SR and MA
5	Hatice Odacı	Turkey 2013	Cross-sectional	ages ranged between 17 and 23	424	Loneliness (UCLA Loneliness Scale)	Problematic Internet use	Beta coefficients	Beta: -.27 T: -5.3 P: 0.01	5	SR and MA
6	Yalçın Özdemir	Turkey 2014	Cross-sectional	mean age of 22.46 years	648	Loneliness (UCLA Loneliness Scale)	Internet addition	correlation	R: .32	6	SR and MA
7	Xinxin Shi	China 2017	Cross-sectional	Mage: 15.771 years old	3289	family functioning and Loneliness as mediator (Asher's Child Loneliness Scale)	Internet addition	NA	NA	6	SR
8	Binnaz Kiran Esena	Turkey, 2013	Cross-sectional	university students	507 university students	Loneliness (UCLA Loneliness Scale)	Internet addition	analysis of Variance	(F(2 497)= 19.56, p<.01).	5	SR
9	Ramazan Abac	Kosovo and Turkey, 2013	Cross-sectional	elderly people		Loneliness (UCLA Loneliness Scale)	Internet addition	analysis of Variance	loneliness level of Turkish people ANOVA F:10.13 P:.000 loneliness level between elderly Kosovo people ANOVA F:3.11 P:.04	4	SR
10	Melahat Akgün Kostak	Turkey, 2018	Cross-sectional	students	881	Loneliness (UCLA Loneliness Scale)	Problematic Internet use	NA	NA	7	SR
11	Hatice Odacı	Turkey, 2010	Cross-sectional	Average age was 17.71 years	493	Loneliness (UCLA Loneliness Scale)	Problematic Internet use	Correlation	R: 0.194 P:<0.001	6	SR and MA
12	Mustafa Tevfik Hebebcı	Turkey, 2018	Cross-sectional	Average age: 22	392	Loneliness (Los Angeles (UCLA) Loneliness Scale)	Internet addition	structural equation modeling (SEM)	Beta = .017	7	SR and MA
13	Anam-ul-Malik	Pakistan, 2016	Cross-sectional	14-33 years	301	Loneliness (Wittenberg Social and Emotional Loneliness Scale)	Internet addition	Beta coefficients of Multiple Hierarchical Regression analysis	Beta: .13 P: 0.00	7	SR and MA
14	Durmuş Ümmet	Turkey, 2016	Cross-sectional	average age was 20.64	237	Loneliness (UCLA Loneliness Scale)	Internet addition	regression analysis	regression analysis F = 48.823, p <.001	6	SR
15	Jale ELDELEKLIOĞLU	Turkey, 2013	Cross-sectional	aged between 15 and 18 years	206	Loneliness (UCLA Loneliness Scale)	Internet addition	Multiple Regression Analysis	internet addiction and loneliness (R = .17, p< .05) Multiple Regression Analysis T: .775 P: .439	6	SR and MA

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Table 1 (continued)

Row	First author	Country and year of publish	Study design	Age of participants	Sample size	exposure	outcome	Effect measure	Effect size	Quality	Final analysis (SR or MA)
16	Signorelli MS	Italy, 2018	Cross-sectional	Ages ranged from 13 to 20 years	551	Loneliness (Los Angeles Loneliness Scale (UCLA-LS))	Internet addition	Odds ratio of Logistic Regression	OR: 1.062 P-Value:<.000	6	SR and MA
17	Meltem Huri Baturay	Turkey, 2019	Cross-sectional	undergraduate students	159	Loneliness (UCLA Loneliness Scale)	Internet addition	NA	NA	5	SR
18	Sun-Mi Cho	Korea, 2013	Cohort	14- to 15-year old male	524 male	Loneliness	IAS(Internet Addiction Scale)	Odds ratio	OR: 1.155 P < .01	6	SR and MA
19	Dr. Nergüz BULUT SERIN	North Cyprus, 2011	Cross-sectional	university students	411	Loneliness (UCLA Loneliness Scale)	Problematic Internet use	Beta coefficients of multiple linear regression analysis	Beta: -.041 P:.166	6	SR and MA
20	Dr. Hasan OZGUR	Turkey, 2014	Cross-sectional	students	311	Loneliness (UCLA-Loneliness Scale III)	Problematic Internet use	regression analysis	[R =.294, R2 =.08, F (1,309)=29.159, p <.01].	7	SR and MA
21	C.C. Frangos	Greece, 2011	Cross-sectional	mean age 20.12±2.4 years	3545	Loneliness	Internet addition	Odds ratio	OR: 2.15 95% CI=1.67-2.71)	6	SR and MA
22	Yaning Guo	China, 2018	Cross-sectional	age from 17 to 25 years	1341	Loneliness (emotional loneliness and social loneliness)	Internet addition	Beta coefficients	Beta: .0135 P < .000	7	SR and MA
23	Yujia REN	China, 2017	Cross-sectional	students	432	Loneliness (Los Angeles Loneliness Scale)	Internet addition	Correlation	R: 0.324 B: 0.13 P: 0.035	8	SR and MA
24	Leo Sang-Min Whang	Korea, 2003	Cross-sectional	20-40 age	13,588	Loneliness	Internet addition	NA	NA	6	SR
25	Elizabeth Hardie	Australia, 2007	Cross-sectional	18-72 years	96	Loneliness (Wittenberg's Emotional and Social Loneliness Scale)	Internet addition	NA	NA	4	SR
26	Dora K. Prievara	Hungary, 2018	Cross-sectional	aged between 14 and 24 years	408	Loneliness (UCLA Loneliness Scale)	Problematic Internet use	Correlation	R: .27	5	SR and MA

NA; Not available, SR; systematic review, MA; meta-analysis, OR; Odds ratio, R; Correlation coefficient, Beta; Beta coefficient of Multiple Regression Analysis.

significant association between IA and loneliness based on the Cohen’s measure (Fig. 2). In addition, according to Fig. 2, there was a high level of heterogeneity ($I^2 = 0.96$) among studies.

3.7. Subgroup analysis based on measures of association

The pooled results of four studies that measured OR values are shown in Fig. 3. The summary effects of OR values showed a significant association between IA and loneliness (OR= 1.16, 95% CI, 1.01–1.33). In addition, according to Fig. 3, there was a high level of heterogeneity ($I^2 = 0.97$) among studies. According to the pooled results of four studies that evaluated bivariate correlation, there was a significant association between IA and loneliness ($r = .26$, 95% CI, 0.22-0.31) (Fig. 4). The heterogeneity among studies that reported bivariate correlation was acceptable (Fig. 4). The pooled results of eight studies that measured beta coefficient values showed a significant association between IA and loneliness ($B = .20$, 95% CI, 0.17-0.22) (Fig. 5). In addition, according to Fig. 5, there was a high level of heterogeneity ($I^2 = 0.97$) between studies.

3.8. Publication bias

Publication bias was evaluated using a Funnel plot and the trim-and-fill method. Studies that measured OR values showed publication bias and, in this case, studies with negative results were not published. In addition, studies that measured bivariate correlation and beta coefficient values showed less publication bias. In total, some evidence of publication bias was found (Supplementary Figs. 1–3). Regarding to Supplementary Figs. 1–3, the funnel plot asymmetry for odds ratios and beta coefficients has taken place. However, combining the effect size to a common metric result in caused a decrease in the amount of this bias

(Supplementary Fig. 5).

3.9. Subgroup analysis based on definition of internet addiction

As a sensitivity analysis, the pooled results of included studies, stratified by definition of internet addiction, are shown in Supplementary Fig. 4. The summary effects of PIU definition shown more strength correlation but the heterogeneity also was more.

4. Discussion

The aim of this study was to evaluate the association between IA and loneliness. The total sample size of the included studies was 16496 subjects. The results of this large sample size from different countries showed a significant positive association between IA and loneliness. The results of our study are in line with other studies which showed that internet addiction is associated with other mental health problems such as depression and anxiety (Wang et al., 2019). Studies also showed a linear association between internet addiction and loneliness, which indicates that individuals with a higher degree of internet addiction exhibited more loneliness than those with a low level of internet addiction (Yen et al., 2008). This phenomenon is called biological gradient (or dose-response) in epidemiology, the Bradford-Hill criteria for causality (Cox, 2018).

Because all included study addresses the same question, in this study reported, the measure of effects was converted to Cohen’s d to estimate the association between IA and loneliness. Converting from different effect measures needs some assumptions about the nature of the underlying traits or effects. Even if these assumptions do not hold exactly, the decision to use these conversions is often better than excluding studies from met analysis. In this situation, a sensitivity analysis to

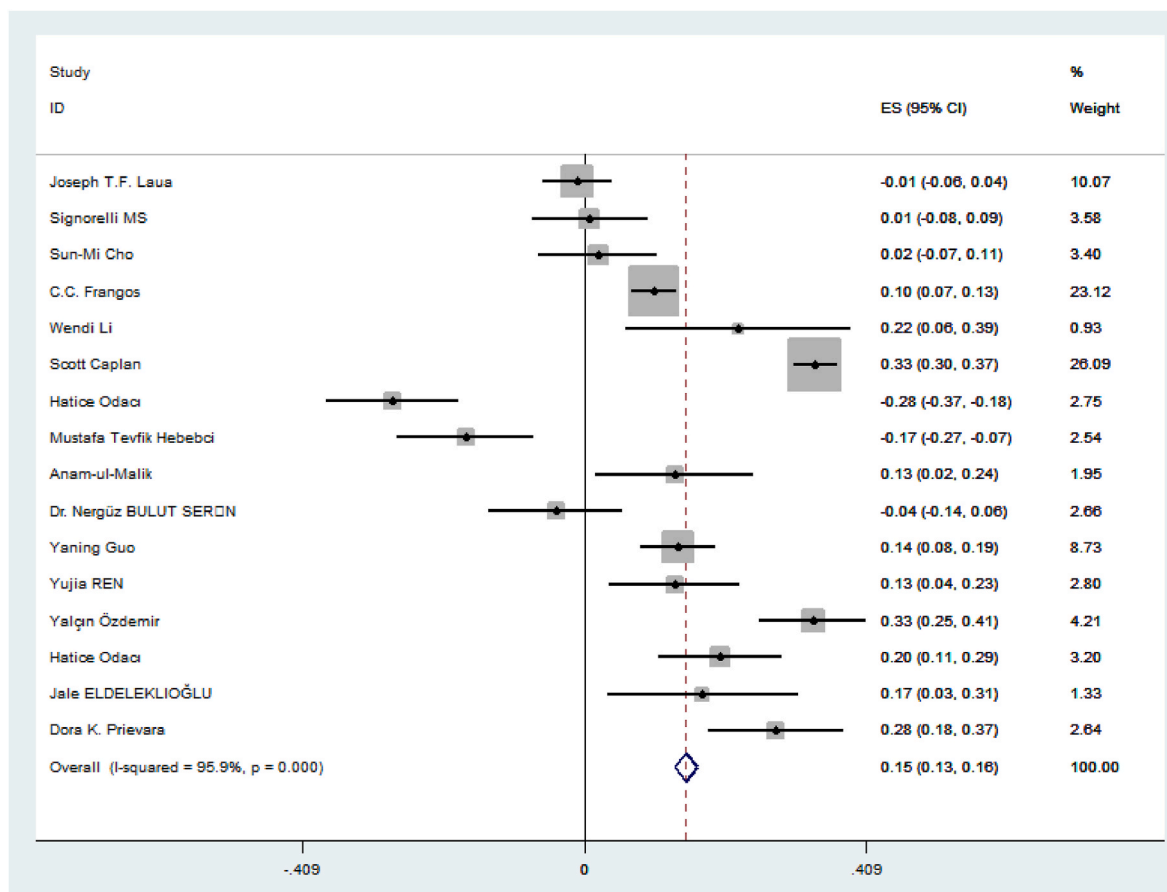


Fig. 2. Forest plot of overall association between loneliness and internet-addicted for all studies included in meta-analysis.

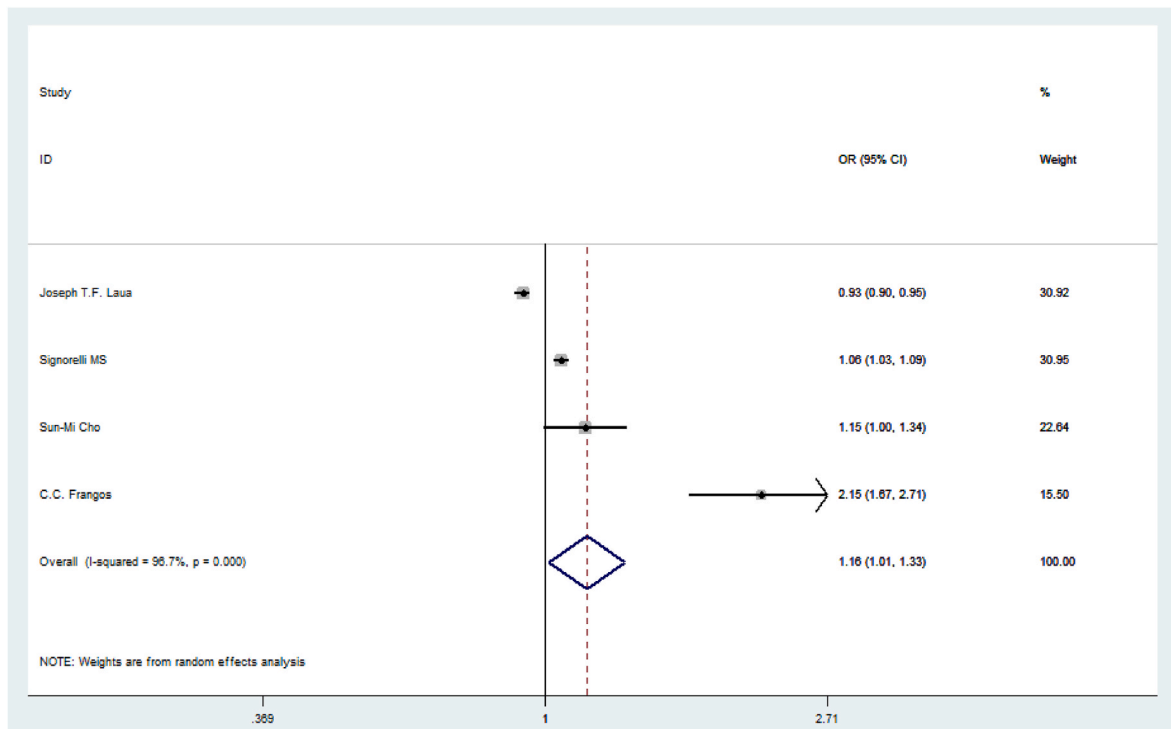


Fig. 3. Forest plot of overall association between loneliness and internet-addicted for studies with odds ratio measures.

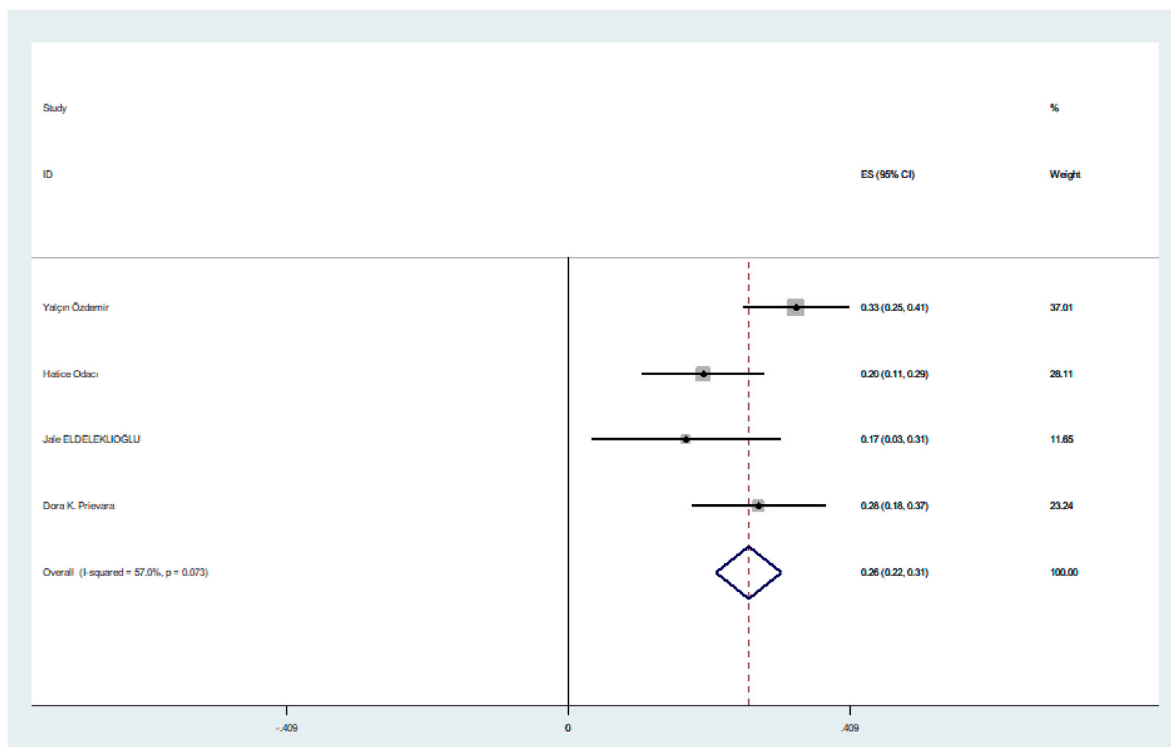


Fig. 4. Forest plot of overall association between loneliness and internet-addicted for studies with correlation coefficient measures.

compare the overall meta-analysis results with converted studies and the meta-analysis result in subgroups of different effect measures is essential (Borenstein et al., 2009). Sensitivity analysis in this study shows that the overall result is the same while result in subgroups of effect measures, so the reliability and validity of the study cannot be affected by combining effect measures.

The reason why people who feel lonely prefer excessive use of the internet may be that these people find a way to cope with loneliness by interacting with other people in these environments (Ryan & Xenos, 2011; Sheldon, 2008).

There are two models for explaining the association between IA and loneliness. First, IA is the cause of loneliness. According to this model,

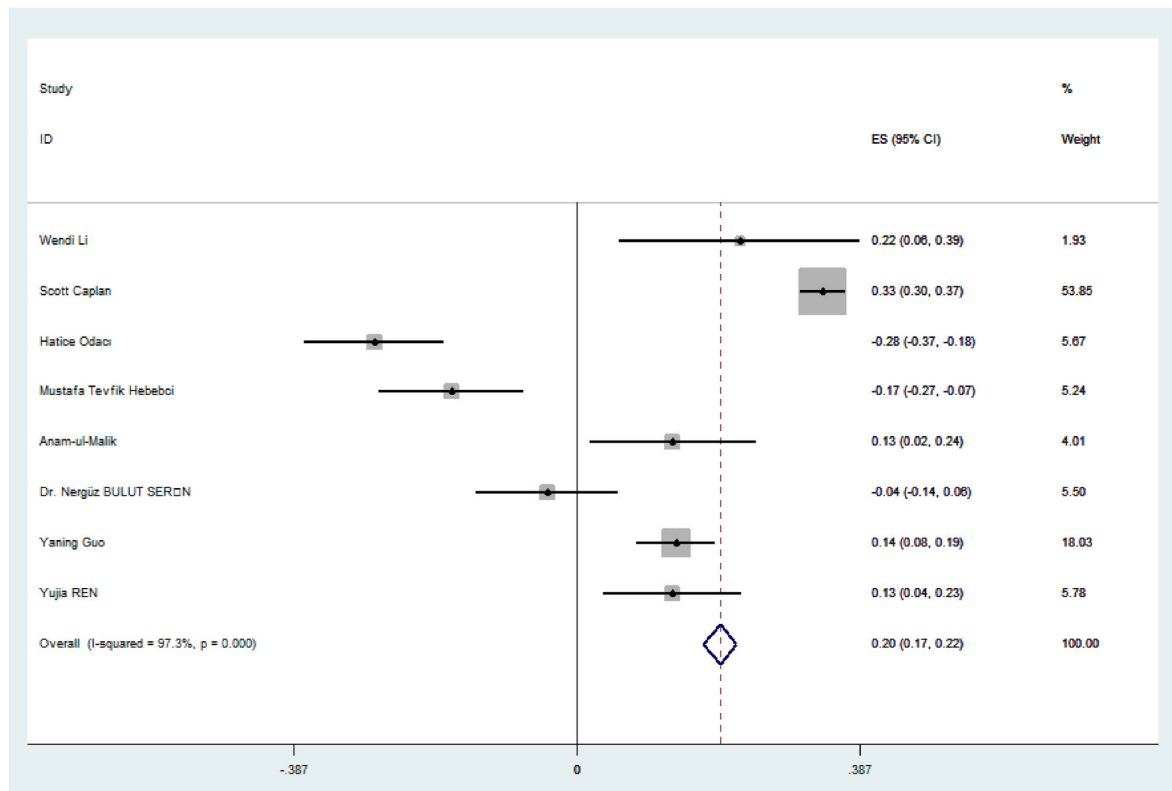


Fig. 5. Forest plot of overall association between loneliness and internet-addicted for studies with beta coefficient measures.

people with IA spend more time online, which results in family and social isolation. These individuals gradually become lonely. Second, loneliness is the cause of IA. According to this model, lonely individuals prefer to increase their communication through social networks to meet their emotional needs.

Other than loneliness, internet addiction is also associated with other mental (Cheung & Wong, 2011) and physical disorders (Ko et al., 2012), lifestyle and dietary behavior (Kim et al., 2010). So, treatment and prevention of internet addiction are essential. Systematic reviews showed that some interventions including physical activities, psychological and pharmacological interventions are very effective for preventing and treating internet addiction (Park, 2009; Winkler et al., 2013; Yeun & Han, 2016).

Several studies have investigated IA (Kwon, 2011, pp. 223–244; Sato, 2006; Tsai & Lin, 2003; Young et al., 2011, pp. 3–17); however, few have evaluated the association between IA and loneliness. Moreover, there is a high level of between-study variation (heterogeneity), which could have resulted from various reasons. The first reason for heterogeneity could be differences in the sample size. The smallest sample size was 74 and the largest was 13,588 (Iacovelli & Valenti, 2009; Whang et al., 2003). The second reason for heterogeneity could be publication year. The eligible studies were published from 2003 to 2019, which could result in immense changes in both internet access and online time (Moreno et al., 2011). The third reason for heterogeneity could be the geographical area of the published study. It seems that the association between IA and loneliness is affected from the prevalence of IA, which ranges from 8.8% in China (Xu et al., 2012) to 20% in Iran (Modara et al., 2017) and 26% in Hong Kong (Shek & Yu, 2012). The articles that were included in this study were conducted in 4 continents and 11 countries. Differences in the methodology, instruments, and study population may be other sources of heterogeneity.

5. Limitations

Although the results of the present study suggested an association between IA and loneliness, there were some limitations. First, most of the included studies were cross-sectional studies, which do not show causality. Therefore, longitudinal studies are required for further research.

Second, due to differences in definitions and instruments for IA and PIU, the results were more accurate in subgroups, however, the number of PIU studies was limited. Moreover, given different concepts of IA and PIU (Fernandes et al., 2019), combining these two concepts could result in some errors. Therefore, future studies should pay more attention to the definition of PIU and IA.

Third is publication bias, the studies with no significant results have lower chance of publishing in high quality English language journals, these articles have more chance of publishing in local journals with other language.

Fourth, the association between Internet addiction (IA) and loneliness can be affected by gender and the age of participants, the results were more informative in subgroup analysis based on gender and age however, due to limited information it was not possible.

Fifth, as regards to the design of included studies, even if there is no methodological problem to converting the effects to a common metric, it may be a bad idea.

6. Conclusion

Based on the results of this study, there is a positive association between loneliness and internet addiction, so policymakers and mental health educators should be aware of the adverse effects caused by internet addiction, as this is such a common phenomenon today. They should make different intervention measures such as physical activities and psychological and pharmacological interventions to prevent and treat internet addiction.

Ethics statement

Analysis for this systematic review is based on published journal articles, and does not constitute human subjects research. No ethics board approval was required.

Financial disclosure

The authors have no financial disclosure.

Authors' contributions

All authors have participated in the concept, design, analysis and/or interpretation of these data, drafting of the manuscript, and assume responsibility for the research. Everyone made substantial contributions to the conception and design, analysis and interpretation of data. The author(s) read and approved the final manuscript.

Declaration of competing interest

All authors declare that they have no conflict of interest.

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None.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ssmph.2021.100948>.

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