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Review article

Systematic review and meta-analysis of epidemiology of internet addiction

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A R T I C L E I N F O

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A B S T R A C T

Background: The field of internet addiction has experienced significant debates on conflicting epidemiology. This meta-analysis investigated the prevalence rates of generalized internet addiction (GIA) and internet gaming disorder (IGD).

Methods: We included 113 epidemiologic studies covering 693,306 subjects published from 1996 to 2018 (for 31 nations) that reported prevalence rates for GIA or IGD. We examined pooled prevalence of GIA and IGD and the hypothesized moderators including year, geographic regions, types of scales, and sample representativeness.

Results: All 133 effect sizes included 53,184 subjects with GIA or IGD. Weighted average prevalence for GIA and IGD were 7.02 % (95 % CI, 6.09 %–8.08 %) and 2.47 % (95 % CI, 1.46 %–4.16 %) respectively. For GIA, prevalence was increased over time and prevalence rates variated among different scales. IGD prevalence was neither moderated by year, regions, nor sample representativeness.

Conclusions: The prevalence of GIA was higher than the prevalence of IGD. The GIA prevalence was increasing over time and variated with different assessments. Our results reveal that GIA may reflect a pattern of increasing human-machine interaction.

1. Introduction

Although Internet addiction has become a popular research topic for more than two decades, the reported prevalence rates of internet addiction may still be influence by the wide range of conceptual approaches. Young (1996) first conceptualized internet addiction as a generalized impulse control disorder based on its core psychopathology—impaired control. Griffiths (1996) described this kind of technological addiction as behavioral addiction that involves human-machine interactions. Similarly, Beard (2005) claimed that internet addiction should classify as a type of behavioral addition. In 2013, the American Psychiatric Association (APA) specified internet addiction as internet gaming disorder (IGD) in Section III research criteria of the DSM-5 (APA, 2013). The World Health Organization (WHO) has also listed “Gaming Disorder” as a substance use and addictive disorders in the ICD-11 beta draft (WHO, 2018). However, the psychopathological foundation of internet addiction is still controversial (King et al., 2018; Rumpf et al., 2018). Most self-report scales evaluating internet addiction were developed based on the criteria of pathological gambling and substance use disorder (Chen et al., 2003; King et al., 2020; Király et al., 2015; Young, 1998). Although internet addiction still lacked consistent diagnostic criteria, there were already a large amount studies that evaluated the prevalence of internet addiction (Cheng and Li, 2014; Li et al., 2018; Shaw and Black, 2008).

In previous studies, the prevalence rates of internet addiction had significant variance ranging from 0.8%–26.7 % (Kuss et al., 2014), dependent on measurement and target population. Although the consequences of internet addiction have been widely researched in recent years, its prevalence and influencing factors are still unclear. For IGD (APA, 2013) and Gaming Disorder (WHO, 2018), both diagnoses refer to functional impairments and unhealthy behaviors due to problematic game use. A recent study found that 63.8 % participants with IGD also fulfilled the Gaming Disorder criteria (Ko et al., 2019). However, there remains uncertainty regarding optimal approaches to screening and assessment for IGD and Gaming Disorder (King et al., 2020; Ko et al., 2019). Most studies have evaluated IGD on the basis of nonstandard

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approaches, such as questionnaires (Yao et al., 2017). Some researchers have cautioned against including Gaming Disorder in the ICD-11 because of insufficient scientific evidence (van Rooij et al., 2018). Additionally, Griffiths and Pontes (2014) suggested that internet addiction and IGD may be different concepts. In a previous meta-analysis, Cheng and Li (2014) found that the pooled prevalence of Internet addiction was 6.0 % in general population. Another recent meta-analysis investigated prevalence of IGD in adolescents and found the pooled prevalence of IGD is 4.1 % (Fam, 2018). Previous empirical research found that IGD was much more strongly associated with being male. In addition, internet addiction was positively associated with online chatting, online gaming, and social networking while IGD was only associated with online gaming (Király et al., 2014). A cross-cultural study also suggested that internet addiction and IGD should be considered separately as two constructs (Montag et al., 2015). All the evidence was consistent with the viewpoint that specific internet addiction such as IGD should be distinguished from generalized internet addiction (Davis, 2001; Fineberg et al., 2018; Montag et al., 2015, 2019). To be clearer, we use “generalized internet addiction (GIA)” in the whole paragraph to represent the interchangeable terms usually described in previous studies such as internet addiction, internet addiction disorder, or problematic internet use.

There was growing evidence that design features of studies, such as year of surveys, geographical regions, assessment tools, and sample representativeness, may greatly influence the prevalence of GIA (Cheng and Li, 2014; Li et al., 2018; Rumpf et al., 2019). Recently, a meta-analysis of GIA prevalence among university students observed that prevalence rates were increasing year by year (Shao et al., 2018). Among all countries, Asian countries have had the highest prevalence and the most significant problems with GIA (Aboujaoude et al., 2006; Block, 2008; Ko et al., 2012). Previous reports showed that East Asian cultures have a higher prevalence rate of GIA than Western cultures, but researchers suggested there was an inflated of prevalence rate in Eastern culture studies (Kuss et al., 2014). In a meta-analysis covering studies from 31 countries to investigate geographical effect on GIA prevalence, the highest prevalence was in the Middle East (10.9 %) and the lowest in Northern and Western Europe (2.6 %) in the general population (Cheng and Li, 2014). A recent survey for IGD showed prevalence varied significantly across different countries (Przybylski et al., 2017). In addition, the divergent prevalence rates could be explained by differences in assessment tools, cut-offs used, and sample representativeness. For example, a meta-analysis found GIA prevalence were significantly higher in studies using 20-item Internet Addiction Test (IAT) and 26-item Chen Internet Addiction Scale (CIAS) than those using 8-item Young Diagnostic Questionnaire (YDQ) (Li et al., 2018). Furthermore, many current epidemiologic studies of GIA adopted non-representative samples (which included the use of convenience samples or lack of proactive recruitment) and may have impacted the prevalence rates. Due to the impact of these factors on prevalence of GIA, it is necessary to re-examine these moderators of GIA and IGD prevalence with meta-analysis.

In light with consideration, there is a need to examine prevalence of GIA and IGD and corresponding moderators. Our primary aim was to determine the pooled prevalence rates of GIA and IGD around the world. Moderators of interest included: 1) year of publication; 2) geographic regions (i.e. Eastern vs. Western countries); 3) different tools for assessing GIA; 4) sample representativeness (i.e. representative vs. non-representative samples).

2. Methods

2.1. Search strategy

Searches of PubMed and PsycINFO used the terms (epidemiology OR prevalence) AND (internet addiction OR isnternet gaming disorder OR problematic internet use). Reference lists from related articles and chapters were combed for other relevant studies. Epidemiologic studies published in English that reported prevalence rates of internet addiction were included. Authors made a consensus decision about any study with ambiguity about inclusion. Fig. 1 shows the flow diagram of literature search. Some articles reported on more than one location of data collection (e.g. cross-country survey). In such cases, all reported effect sizes of prevalence rates were included in the meta-analysis. When more than one study reported on the same sample, we chose the effect size associated with the most recent and/or complete data from a given study. The search was updated December 2018.

2.2. Study coding

Data extraction and coding followed the same methods as a previous meta-analysis of the prevalence of Internet addiction (Cheng and Li, 2014; Li et al., 2018). Data on prevalence of GIA and IGD, sample demographic data, country variables, assessment tools, cutoff point of assessment tools, sample representativeness were coded. The first author (YC Pan) and the corresponding author (YH Lin) in this study coded all studies.

2.3. Meta-analysis

We used the metaphor and metaviz package in R to meta-analyze the data (Kossmeier et al., 2019; Viechtbauer, 2010). Prevalence rates were transformed using logit transformation, in order to normalize the data distribution, with inverse variance weighting (Huedo-Medina et al., 2006). A random effects model estimated the average weighted prevalence for GIA and IGD. We also calculated prevalence rates of GIA and IGD for geographic regions separately. Cochran Q statistic assessed whether prevalence rates were homogeneous across samples. The degree of heterogeneity of estimates across studies is examined using I^2 index (Huedo-Medina et al., 2006). The I^2 value above 50 % and 75 % signals the existence of heterogeneity and high heterogeneity respectively (Higgins and Thompson, 2002). Mixed-effects meta-regression tested whether prevalence of GIA and IGD changed over time or across regions, controlling other design predictors. Meta-regression analyses were then carried out to identify moderators that explained the heterogeneity of prevalence.

3. Results

The search netted a total of 133 effect sizes from 31 different countries, from studies conducted from 2003 to 2018, covering 53,184 cases with GIA and IGD, with a total of 693,306 participants. Table 1 lists all the studies included in the analyses. Funnel plot and Egger test indicated publication bias, with a tendency to omit studies with high rates for both GIA (t = -2.18, df = 114, p = .031) and IGD (t = -2.68, df = 15, p = .017). The pooled prevalence for GIA and IGD were 7.02 % (95 % CI, 6.09 %–8.08 %) and 2.47 % (95 % CI, 1.46 %–4.16 %), respectively. There was significant heterogeneity among GIA studies (Q_E = 28760.22, df = 115, p < .0001; H^2 = 250.09, I^2 = 99.60 %) and among IGD studies (Q_E = 1512.96, df = 16, p < .0001; H^2 = 94.56, I^2 = 98.94 %). Forest plot of GIA and IGD prevalence by study were shown in Figs. 2 and 3, respectively.

3.1. Meta-regression analyses

Table 2 shows GIA and IGD prevalence and the effect of hypothesized moderators. For studies reported prevalence rates of GIA (k = 117), the prevalence of GIA significantly increases with year of publication (β = 0.006, p = .002). Fig. 4 demonstrates the change in prevalence rates of GIA overtime. The pooled prevalence is 16.00 % for CIAS, 8.51 % for IAT, 5.06 % for YDQ, and 4.17 % for other tools. In addition, the pooled prevalence rates are significantly higher in studies using CIAS (β = 0.083, p = .002) than YDQ. For studies using IAT to assess rates of GIA (k

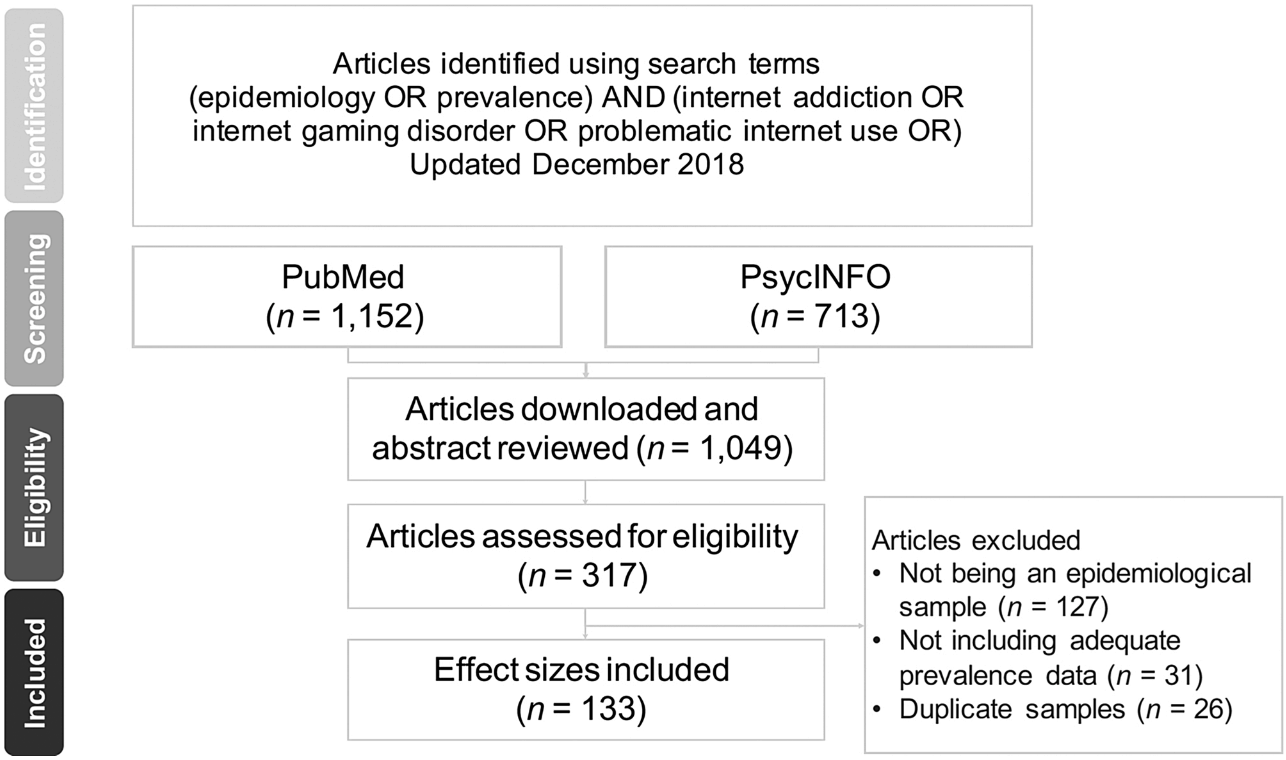

Fig. 1. Flow Diagram of Literature Search.

= 61), there was a significant difference in prevalence between using strict (i.e. score more than 60) or broad (i.e. score more than 50) definition of cutoff point (R^2 = 38.07 %, Q_M = 22.513, p < .001). Geographic regions did not significantly explain variance in the rate of GIA (β = –0.015, p = .377). Sample representativeness also did not significantly explain variance in the rate of GIA (β = –0.027, p = .119).

For studies that reported prevalence rate of IGD (k = 16), year of publication (β = 0.008, p = .512), geographic regions (β = 0.008, p = .299), and sample representativeness (β = 0.006, p = .807) did not significantly explain variance in the rate of IGD (Table 2).

4. Discussion

To our knowledge, this is the first meta-analysis directly comparing prevalence rates of GIA and IGD. We extend previous works on GIA or IGD prevalence (Cheng and Li, 2014; Fam, 2018; Li et al., 2018), to independently compare prevalence rates of GIA and IGD and to completely include studies from 1996 to 2018. The pooled prevalence for GIA (7.02 %) was higher than which for IGD (2.47 %). The GIA prevalence increased over time. This trend was not shown for the prevalence of IGD. Although GIA was proposed and became a popular research topic since 1990s, there has been no consistent diagnostic criteria. A recent meta-analysis investigated prevalence of IGD in adolescents and found the pooled prevalence of IGD was 4.1 % (Fam, 2018). This analysis also found that studies applied validated measures based on IGD in DSM-5 were likely to reported lower prevalence and narrower confidence interval than the GIA studies adopted measures developed from DSM criteria of pathological gambling.

Our primary findings show that the prevalence rates are significantly different between GIA and IGD. It is consistent with the viewpoint that specific internet gaming addiction should be distinguished from GIA (Davis, 2001; Montag et al., 2015). A large international study investigated clinical phenomenon and prevalence of IGD symptoms. They found that a very small proportion (1 %) of the general population met the diagnosis of IGD (Przybylski et al., 2017). It may indicate that IGD is a distinct entity from GIA. In addition, our results reveal that pooled prevalence is divergent among different tools used for assessing GIA. Almost all of them diagnosed GIA by self-reported scales rather than using structured interview based on diagnostic criteria. Previous studies adopted different diagnostic models for evaluating core psychopathology of GIA. For example, due to Young (1998) conceptualized GIA as a generalized impulse control disorder, YDQ and IAT were further constructed based on the diagnostic criteria of pathological gambling in DSM-IV-TR (Young, 1996, 1998). Another study developed diagnostic criteria for GIA based on the diagnostic framework of substance use disorders (Ko et al., 2005). Consist with our finding, a previous meta-analysis also found IA prevalence were significantly higher in studies using IAT and CIAS than those using YDQ (Li et al., 2018). YDQ was comprised of eight core symptoms for GIA. In contrast, IAT and CIAS included more peripheral symptoms other than impaired control, such as time management and social problems, which may generate overestimated prevalence rates. In addition, we also found a significant difference in prevalence between using strict or broad definition of cutoff point for IAT. It is consistent to the finding of previous meta-analysis (Li et al., 2018). The heterogeneous prevalence rates could be explained by differences in assessment tools and cut-offs used.

Our results reveal that prevalence rates of GIA are increasing over time. A meta-analysis of GIA prevalence among university students also observed the prevalence reveals an increasing trend year by year (Shao et al., 2018). Our findings further examine the moderation effect of year and found that only GIA but not IGD shows a rising time trend on prevalence. This trend is consistent with the increasing exposure of screen time over past decades (Madigan et al., 2019). There is a growing body of evidence supports that psychology should start to move away from a behavioral framework when investigating technology use (Panova and Carbonell, 2018). GIA represents a behavioral pattern or habituation involving frequent human–machine interactions for digital generations, and could possibly not be conceptualized as addictive or problematic (Ellis et al., 2019). The prevalence estimates of GIA may be affected by methodological inconsistencies. In addition, an emerging but crucial issue is the reliability of diagnosis. Even with proposed diagnostic criteria of IGD in DSM-5, there is a continual lack of consensus on

Table 1
Studies included in meta-analysis.

First Author	Year of Publication	Prevalence	Total N	Location	Region (East/West)	Measures
Generalized Internet Addiction (k = 116)						
Ak	2013	5.00 %	4311	Turkey	E	IAT
Al-Gama	2016	40.00 %	587	Jordan	E	IAT
An	2014	11.70 %	13,723	China	E	IAT
Bakken	2009	1.00 %	3393	Norway	W	YDQ
Bener	2018	17.70 %	2350	Turkey	E	IAT
Bhandari	2017	35.40 %	937	Nepal	E	IAT
Bruno	2014	3.90 %	1035	Italy	W	IAT
Canan	2012	9.70 %	1034	Turkey	E	Other
Cao	2007	2.40 %	2620	China	E	YDQ
Chen	2015	11.40 %	1153	Taiwan	E	CIAS
Chen	2016	8.70 %	5249	China	E	IAT
Chi	2016	15.20 %	1173	China	E	IAT
Choi	2009	2.50 %	2336	Korea	E	IAT
Christakis	2011	4.00 %	307	US	W	IAT
Di Nicola	2017	22.10 %	996	Italy	W	IAT
Dufour	2016	18.00 %	3938	Canada	W	IAT
Durkee	2012	3.10 %	943	Austria	W	YDQ
Durkee	2012	5.30 %	1034	Estonia	W	YDQ
Durkee	2012	2.60 %	1003	France	W	YDQ
Durkee	2012	4.80 %	1438	Germany	W	YDQ
Durkee	2012	1.60 %	1008	Hungary	W	YDQ
Durkee	2012	3.80 %	1067	Ireland	W	YDQ
Durkee	2012	11.80 %	951	Israel	E	YDQ
Durkee	2012	1.20 %	1188	Italy	W	YDQ
Durkee	2012	4.60 %	1136	Romania	W	YDQ
Durkee	2012	5.80 %	1164	Slovenia	W	YDQ
Durkee	2012	4.30 %	1024	Spain	W	YDQ
Frangos	2011	12.00 %	2293	Greece	W	YDQ
Fu	2010	6.70 %	208	Hong Kong	E	YDQ
Ghassemzadeh	2008	1.90 %	1968	Iran	E	IAT
Gómez	2017	16.30 %	40,955	Spain	W	Other
Gong	2009	5.50 %	3018	China	E	YDQ
Guo	2018	2.20 %	20,895	China	E	IAT
Gupta	2018	25.30 %	380	India	E	IAT
Ha	2014	2.80 %	56,086	Korea	E	Other
Huang	2009	9.60 %	3496	China	E	YDQ
Islam	2016	24.00 %	573	Bangladesh	E	IAT
Jiang	2012	6.90 %	697	China	E	CIAS
Johansson	2004	2.00 %	1591	Norway	W	YDQ
Kaess	2016	11.50 %	1572	Estonia	W	YDQ
Kaess	2016	5.10 %	2573	Germany	W	YDQ
Kaess	2016	4.40 %	2138	Italy	W	YDQ
Kaess	2016	8.70 %	1245	Romania	W	YDQ
Kaess	2016	7.20 %	1339	Spain	W	YDQ
Kaltiala-Heino	2004	1.50 %	7229	Finland	W	Other
Kawabe	2016	2.00 %	835	Japan	E	IAT
Kim	2005	2.90 %	769	Korea	E	YDQ
Kim	2006	1.50 %	1573	Korea	E	IAT
Kim	2016	9.30 %	6510	Korea	E	IAT
Kitazawa	2018	38.20 %	1258	Japan	E	IAT
Ko	2007	17.70 %	517	Taiwan	E	CIAS
Ko	2009	10.80 %	2162	Taiwan	E	CIAS
Lam	2009	0.60 %	1618	China	E	IAT
Lau	2017	16.00 %	8286	Hong Kong	E	CIAS
Lau	2018	28.10 %	9666	Hong Kong	E	CIAS
Lee	2014	2.40 %	1217	Korea	E	Other
Li	2014	6.30 %	24,013	China	E	YDQ
Lin	2011	15.30 %	3616	Taiwan	E	CIAS
Lin	2018	17.40 %	2170	Taiwan	E	CIAS
Liu	2011	4.00 %	3560	US	W	Other
Liu	2017	17.10 %	2479	Taiwan	E	CIAS
Lopez-Fernandez	2013	5.00 %	1131	Spain	W	Other
Lu	2018	14.10 %	1385	China	E	IAT
Macur	2016	3.10 %	6029	Slovenia	W	Other
Malak	2017	6.30 %	716	Jordan	E	IAT
Mei	2016	5.50 %	1552	China	E	YDQ
Mihara	2016	7.90 %	100,050	Japan	E	YDQ
Müller	2014	2.10 %	2512	Germany	W	Other
Müller	2017	2.60 %	9293	Germany	W	Other
Ni	2009	6.40 %	3557	China	E	IAT
Niemz	2005	18.30 %	371	British	W	Other
Pallanti	2006	5.40 %	275	Italy	W	IAT
Pan	2018	23.00 %	1507	Taiwan	E	CIAS

(continued on next page)

Table 1 (*continued*)

First Author	Year of Publication	Prevalence	Total N	Location	Region (East/West)	Measures
Park	2008	10.70 %	903	Korea	E	IAT
Park	2017	1.00 %	3723	Korea	E	YDQ
Poli	2012	0.80 %	2533	Italy	W	IAT
Poorolajal	2018	24.50 %	4261	Iran	E	IAT
Prabhakaran	2016	8.70 %	724	India	E	IAT
Reiner	2017	15.70 %	2410	Germany	W	Other
Rumpf	2014	1.00 %	14,022	Germany	W	Other
Sasmaz	2014	15.10 %	1156	Turkey	E	Other
Seyrek	2017	1.60 %	468	Turkey	E	IAT
Shek	2008	26.40 %	3328	Hong Kong	E	IAT
Shek	2016	17.00 %	3498	Hong Kong	E	IAT
Siomos	2012	16.10 %	1199	Greece	W	YDQ
Siomos	2008	8.20 %	2200	Greece	W	YDQ
Tabatabaee	2018	12.70 %	928	Iran	E	IAT
Takahashi	2018	5.40 %	8209	Japan	E	YDQ
Tang	2014	6.00 %	755	China	E	IAT
Tang	2018	8.00 %	1244	US	W	IAT
Tang	2018	9.30 %	1119	Singapore	E	IAT
Tang	2018	5.70 %	838	Hong Kong, Macau	E	IAT
Tang	2018	13.80 %	1090	China	E	IAT
Tang	2018	6.10 %	968	Korea	E	IAT
Tang	2018	6.50 %	1793	Taiwan	E	IAT
Tang	2018	12.90 %	1015	Japan	E	IAT
Tateno	2016	3.70 %	403	Japan	E	IAT
Tateno	2018	4.70 %	602	Japan	E	IAT
Thomas	2010	4.60 %	2031	Austria	E	YDQ
Tsai	2009	17.90 %	3806	Taiwan	E	CIAS
Ustinavičienė	2016	18.30 %	1806	Lithuania	W	YDQ
Vigna-Taglianti	2017	12.10 %	2022	Italy	W	IAT
Villella	2011	1.20 %	2853	Italy	W	IAT
Wang	2011	12.20 %	14,296	China	E	IAT
Wang	2016	16.00 %	9518	Hong Kong	E	CIAS
Wartberg	2015	3.20 %	1723	Germany	W	Other
Wartberg	2016	4.80 %	1444	Germany	W	YDQ
Whang	2003	3.50 %	13,588	Korea	E	IAT
Wu	2016	10.40 %	10,158	China	E	IAT
Wu	2016	25.30 %	2021	Hong Kong	E	IAT
Xin	2018	26.50 %	6468	China	E	IAT
Xu	Xu et al., 2012	8.80 %	5122	China	E	Other
Yang	2018	15.50 %	4750	China	E	IAT
Yen	2007	17.90 %	2114	Taiwan	E	CIAS
Yoo	2014	3.00 %	74,980	Korea	E	Other
Zadra	2016	0.50 %	15,023	Germany	W	Other
Internet Gaming Disorder (k = 17)						
Buiza-Aguado	2018	8.30 %	708	Spain	W	Gaming
Chiu	2018	3.10 %	8110	Taiwan	E	Gaming
De Pasquale	2018	14.90 %	221	Italy	W	Gaming
Evren	2018	1.00 %	1250	Turkey	E	Gaming
Männikkö	2015	8.20 %	293	Finland	W	Gaming
Milani	2018	2.10 %	612	Italy	W	Gaming
Pontes	2016	2.50 %	1071	Slovenia	W	Gaming
Przybylski	2017	1.00 %	1247	US	W	Gaming
Przybylski	2017	0.50 %	1899	UK	W	Gaming
Przybylski	[Przybylski et al., 2017]2017	0.70 %	10,009	US, England	W	Gaming
Przybylski	2017	0.30 %	5888	US	W	Gaming
Rehbein	[Rehbein et al., 2015]2015	1.20 %	11,003	Germany	W	Gaming
Wang	[Wang et al., 2016]2018	10.80 %	7200	Korea	E	Gaming
Wartberg	[Wartberg et al., 2017]2017	5.70 %	1531	Germany	W	Gaming
Wu	[Wu et al., 2018]2018	2.00 %	1000	China	E	Gaming
Wu	2018	1.90 %	2147	Taiwan	E	Gaming
Yu	[Yu and Cho, 2016]2016	5.90 %	2024	Korea	E	Gaming

Note. E, Eastern country; W, Western country; YDQ, Young diagnostic Questionnaire; IAT, Internet addiction test; CIAS, Chen Internet addiction scale.

how best to assess IGD (Pontes and Griffiths, 2014). It might explain why the heterogeneity is still high after considering design features of studies in the current analysis. Researchers and clinicians should begin to apply a common conceptualization to investigate GIA and IGD. Future meta-analysis focused on the prevalence of IGD and Gaming Disorder is also crucial and urgently needed.

Previous studies have shown Eastern countries have higher prevalence rates of GIA than Western countries (Kuss et al., 2014). Such cultural discrepancies have been linked to parenting attitude toward Internet use (Griffiths et al., 2016). However, we found that people in Eastern society are not more likely to develop GIA than people in Western society in meta-regression model. Although there was significant difference in GIA prevalence between Eastern (8.90 %) and Western (4.60 %) society in subgroup analysis, we found that people in Eastern society are not more likely to develop GIA than people in Western society in meta-regression model. This result indicates that direct links between higher prevalence in Eastern countries to parenting attitude may be not a valid explanation. A previous meta-analysis also found that the pooled prevalence of GIA was 6.0 % in the general population with the highest prevalence in the Middle East (10.9 %) and the lowest in

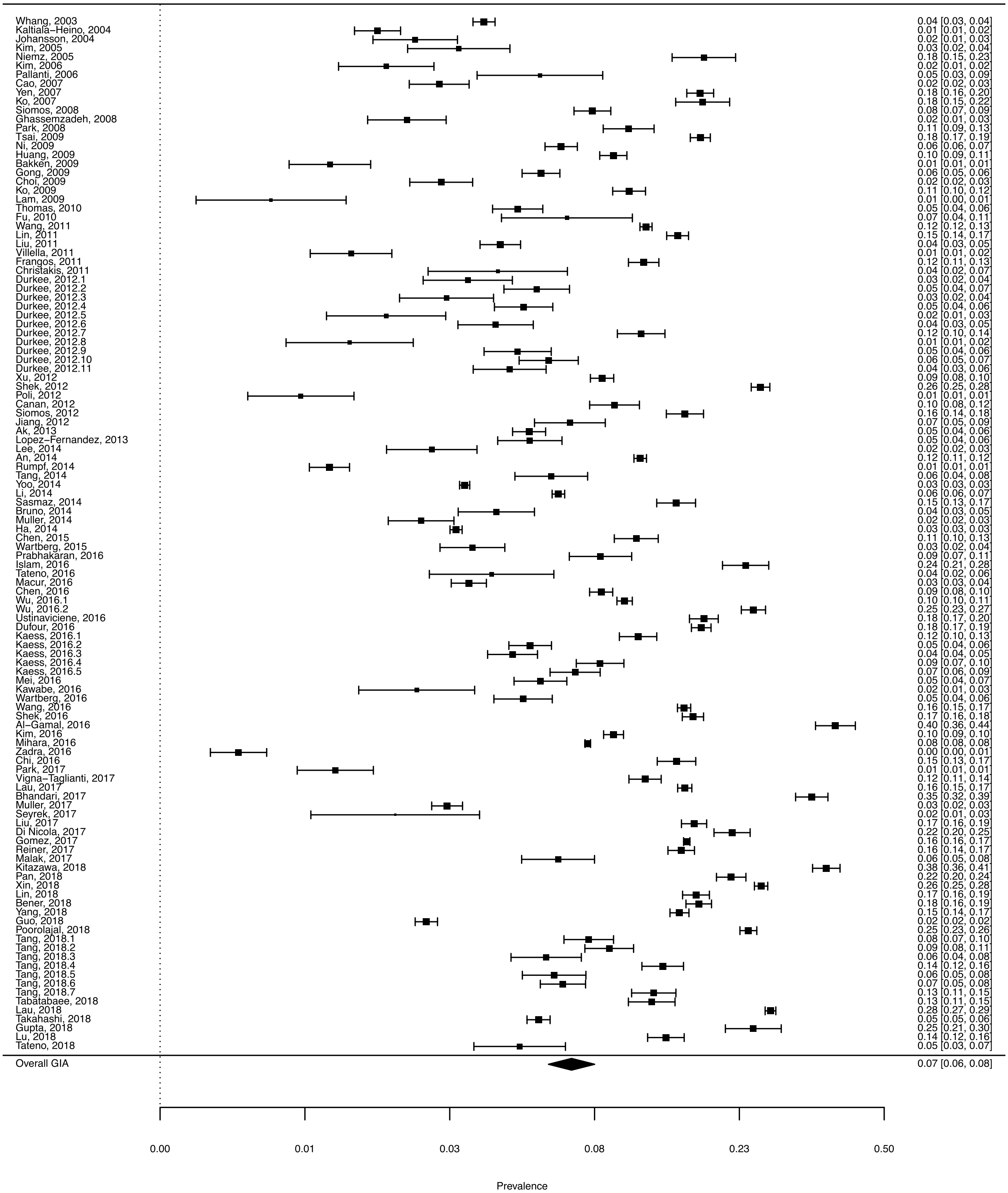

Fig. 2. Forest Plot of GIA Prevalence by Study, Sorted by Year of Publication.

Northern and Western Europe (2.6 %) in the general population (Cheng and Li, 2014). In addition, with the great demands for online activities in Eastern countries, it seems reasonable to see more addicted users in these regions. Our results were inconsistent with other studies suggesting that GIA prevalence is inflated in Eastern oriental culture studies (Cheng and Li, 2014; Fam, 2018). It is possible that, as progress of technology and time, the discrepancies of Internet use behaviors become similar worldwide. Therefore, more research on GIA and IGD in Eastern countries is needed.

There are several methodological limitations that should be noted. First, some factors were not reported in enough detail to be included as moderators, such as symptom duration used in assessment tools. Second, the current study did not account for the potential age differences in prevalence of GIA and IGD. Participants' ages were initially coded in this study. However, comparison of the age groups is almost impossible due to inconsistent reports or lack of reports of age (i.e. 51 in 133 studies).

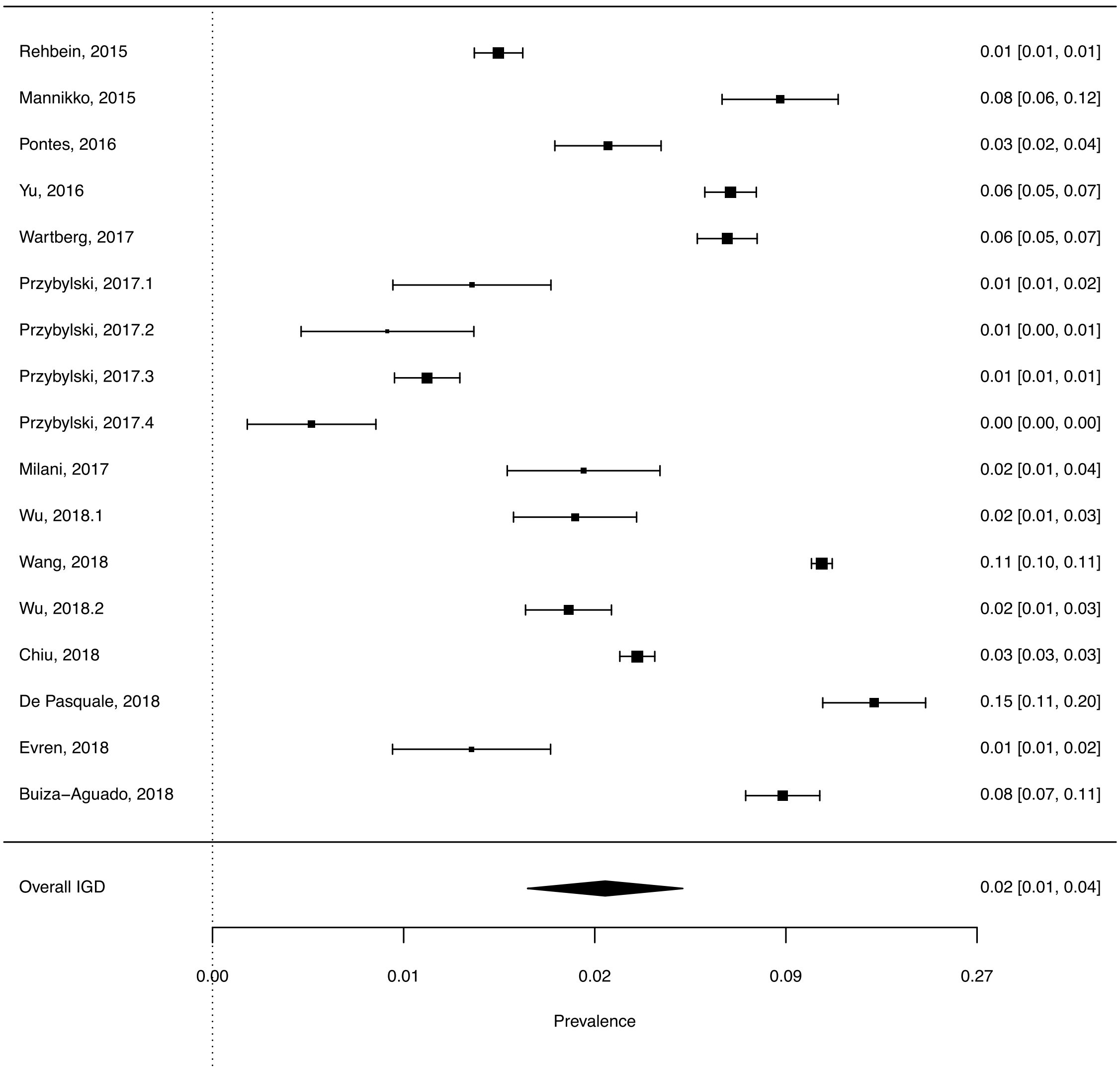

Fig. 3. Forest Plot of IGD Prevalence by Study, Sorted by Year of Publication.

Table 2
Generalized Internet Addiction and Internet Gaming Disorder Prevalence by Geographic Region, Measures, and Sample Representativeness.

Subgroups	Categories	*k*	Prevalence (%)	95 % CI (%)	I^2	*Q*	*p*-value[a]
GIA		116	7.02	6.09–8.08	99.60 %	28760.22	< .001
Geographic region	East	73	8.90	7.46–10.59	99.67 %	22086.54	< .001
	West	43	4.60	3.47–6.08	99.36 %	6571.47	< .001
Measures	YDQ	34	5.06	4.35–5.87	97.78 %	1488.67	< .001
	IAT	51	8.51	6.95–10.39	99.41 %	8409.09	< .001
	CIAS	13	16.00	13.40–18.99	98.59 %	852.85	< .001
	Other	18	4.17	2.49–6.90	99.84 %	10493.12	< .001
Representative sample	Yes	86	6.06	5.14–7.14	99.66 %	24674.31	< .001
	No	30	10.63	8.32–13.49	98.86 %	2532.85	< .001
IGD		17	2.47	1.46–4.16	98.94 %	1512.96	< .001
Geographic region	East	6	3.10	1.54–6.16	98.98 %	492.13	< .001
	West	11	2.19	1.06–4.46	98.32 %	594.56	<. 001
Representative sample	Yes	10	3.38	2.18–5.19	97.08 %	308.01	<. 001
	No	7	1.55	0.39–5.91	99.34 %	913.45	<. 001

Note. GIA, generalized Internet addiction; IGD, Internet gaming disorder; YDQ, Young diagnostic Questionnaire; IAT, Internet addiction test; CIAS, Chen Internet addiction scale.
[a] *p*-value stands the significant heterogeneity.

Therefore, we decided to omit coding age in the current study. Future study should consider the influence of age on prevalence of GIA and IGD. Third, the elements of game design are somewhat different between computer gaming and mobile gaming. The diversity of internet games is also increasing with time. Mobile games have become a crucial factor in smartphone use and may need to be discussed separately (Liu et al., 2016). Further meta-analysis focused on IGD or mobile gaming is needed. Fourth, our search strategy may neglect some studies which did

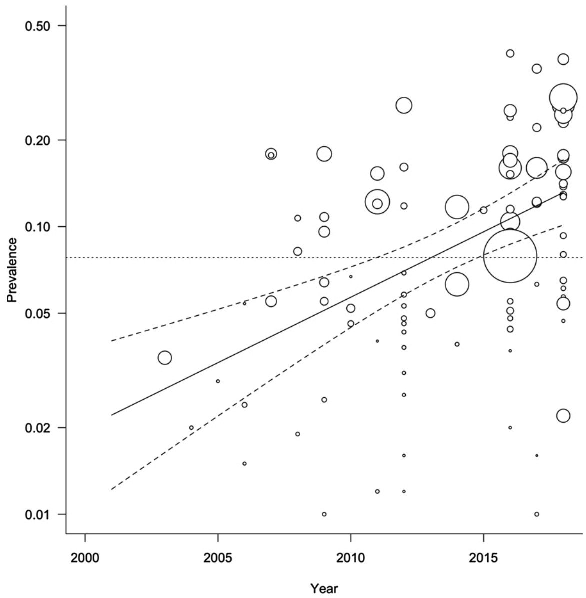

Fig. 4. Prevalence Rates for Generalized Internet Addiction. The change in rates of generalized Internet addiction is significant over time. Circle size indicates the weight due to sample size and precision of estimates. The solid line indicates the prevalence over time. The point line indicates the overall prevalence of GIA (7.02 %). The dash lines indicate 95 % confidence interval of prevalence.

report the proportion of GIA or IGD but not use the word "prevalence" or "epidemiology" in the abstract. This strategy may avoid enhancing heterogeneity but may also omit some potential prevalence data.

In conclusion, the prevalence of GIA is higher than the prevalence of IGD. For GIA, the prevalence rates variated with year and are different among assessment tools. For IGD, the prevalence was neither moderated by year nor countries. The high heterogeneity of GIA prevalence may due to methodological inconsistencies. For future prevalence study of GIA, it is crucial to adopted a consistent and precise assessment tool focused on core symptoms of GIA rather than time spent on internet. IGD is comparatively a more stable diagnostic concept, which is more appropriate to be applied to cross-cultural studies.

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Declaration of Competing Interest

All authors declare that they have no conflict of interest.

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