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Prevalence of gaming disorder in East Asia: A comprehensive meta-analysis

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REVIEW ARTICLE

ABSTRACT

Background and aims: Asian countries are deemed to be high prevalence areas for gaming disorder (GD). This meta-analysis is the first to synthesize the overall prevalence of GD in East Asia and investigate characteristics that influence prevalence estimates. *Methods:* Systematic and independent searches were conducted across PubMed, Web of Science, Embase, PsycINFO, and the Cochrane Library since their inception to January 27, 2021. The Agency for Healthcare Research and Quality scale was used for quality assessment. A random effect model was used to calculate the overall GD prevalence and 95% confidence intervals (CIs). *Results:* In total, 22 articles (26 studies) comprising 51,525 participants were included in this meta-analysis. The overall pooled prevalence of GD in East Asia was 12%, 95% CI (10%–15%); this figure was adjusted to 6%, 95% CI (3%–9%) for a representative sample. Higher prevalence was observed in males than in females (16% vs. 8%, respectively, $P < 0.05$). Subgroup and meta-regression analyses revealed that studies among gamers or those without random sampling reported significantly higher prevalence rates. There were no significant differences between countries/regions, sample size, quality score, proportion of males, and scale used. *Discussion and conclusions:* The prevalence of GD in East Asia is higher than that in other world regions. Future studies should extend such epidemiological research to other regions to calculate the accurate prevalence of GD to benefit the local identification, prevention, policy formulation, and treatment efforts. Considering its negative effects, effective preventive and treatment measures for GD in East Asia need greater attention.

KEYWORDS

gaming disorder, meta-analysis, high prevalence, East Asia, gender

INTRODUCTION

Gaming disorder (GD) is characterized as a persistent, compulsive, and uncontrollable pattern of gaming use that induces impairment and distress in a person's health, social, relational, occupational, and financial domains (Derevensky, Hayman, & Gilbeau, 2019). Research into GD has grown rapidly since 2013 when the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) (APA, 2013) identified Internet gaming disorder (IGD) as an emerging disorder that needed future research (Griffiths, King, & Demetrovics, 2014). A number of countries and experts have explored empirical evidence to officially labeled IGD as a behavior addiction due to its dysfunction and potential damages (Brand, Rumpf, King, Potenza, & Wegmann, 2020; Humphreys, 2019; Saunders et al., 2017). Until 2019, The World Health Organization formally included GD as an addictive behavior in the International Classification of Diseases (WHO, 2018). The ICD-11 defined GD as a dysfunctional gaming pattern, both online and offline, and proposed diagnostic criteria including loss

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of control, prioritization of gaming over other activities, and persistent or increased gaming behavior despite negative effects.

Based on the refinement of the diagnostic criteria for GD, there has been a tremendous growth in epidemiological studies done to establish the prevalence of GD globally (Chia et al., 2020). However, Asian countries have always witnessed high prevalence of GD. A meta-analysis conducted in 2018 that included 16 studies spanning the previous three decades, calculated the prevalence of IGD in adolescents as 4.6%, and subgroup analyses revealed that prevalence estimates were higher when studies were conducted in Asia (Fam, 2018). Another meta-analysis conducted in 2020 that included 53 papers reported the global prevalence as 3.05% and the prevalence was also higher in Asia (5.08%) than in Europe (2.72%) (Stevens, Dorstyn, Delfabbro, & King, 2021). A cross-sectional study that enrolled 8,067 college students from Singapore, Hong Kong, Macau, Taiwan, mainland China, South Korea, Japan, and the United States compared the prevalence of GD between the aforementioned counties and region. Asian and American students displayed higher risks of online gaming addiction (Tang et al., 2018). Asian countries and the United States are consistently deemed to be higher prevalence areas for GD than European countries (Rehbein, Kliem, Baier, Moessle, & Petry, 2015) and Australia (King, Delfabbro, Zwaans, & Kaptsis, 2013).

In Asian counties, especially China and South Korea, the existence of huge gaming use populations (Cui, Lee, & Bax, 2018) and a high prevalence of GD (Xiang et al., 2020) have been reported. In recent years, China and South Korea have led the research into both the epidemiology and the etiology of GD. A rapid scoping review conducted in 2020 that assessed 5,550 potentially relevant citations about GD found 160 studies of various designs that used 35 different methods to diagnose IGD/GD. It reported a prevalence of IGD that ranged from 0.21% to 57.50% in the general population, indicating significant differences that are attributable to differences in cultural background and family upbringing between countries and regions, and most of the studies reviewed were conducted in South Korea and China (Darvesh et al., 2020).

There are many countries in Asia, and the cultural background of each country and region are considerably varied, mainly due to religious and regional factors. A meta-analysis that included the Southeast Asian countries of Brunei, Myanmar, Cambodia, Timor-Leste, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, and Vietnam reported the prevalence of GD as 10.1% (Chia et al., 2020). A meta-analysis conducted in the Gulf Cooperation Council (GCC) region reported that the prevalence of Internet addiction was 33%, and it was significantly higher among females (48%) than males (24%) (Al-Khani et al., 2021). These authors recommended that such epidemiological research should be extended to countries or regions that have not been studied or are under-studied. Inspired by Chia et al. and Al-Khani et al., we aimed to explore the prevalence of GD in East Asian countries (China, South Korea, Japan, North Korea, and Mongolia) which have similar cultural backgrounds to provide accurate date regarding GD prevalence thus benefiting the further identification of GD, its prevention, and informing policy and treatment research.

This study, the first meta-analysis of GD prevalence research conducted in East Asia, included all prevalence-related publications on GD from East Asian countries. In contrast to previous meta-analyses, this study excluded research on tool development or scale validation for more accurate data (Fam, 2018), and also excluded studies that did not define IGD/GD clearly or did not use IGD/GD-related assessment tools (Stevens et al., 2021). The specific objectives were to (1) synthesize the overall prevalence of GD in East Asia, (2) examine gender difference in the prevalence of GD, and (3) investigate how study characteristics influenced the prevalence estimates. The study characteristics included country, sample size, sample selection, sample strategy, quality score, proportion of males, and assessment tool.

METHODS

Protocol and registration

This meta-analysis followed the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) guidelines (Moher, Liberati, Tetzlaff, Altman, & Grp, 2009). The review protocol was submitted to the International Prospective Register of Systematic Reviews (PROSPERO) in January 2021 for registration before the screening of search results and analysis of data began. The PROSPERO registration number is CRD42021234271.

Search strategy and study selection

Two of the authors systematically and independently searched five databases—PubMed, Web of Science, Embase, PsycINFO, and the Cochrane Library—since their inception to January 27, 2021. The following search terms with combinations of keywords were used: (“gaming” or “game”) and (“disorder” or “addiction” or “problematic” or “pathological” or “dependent” or “compulsive” or “excessive” or “overuse” or “heavy”) and (“prevalence” or “survey” or “cross-sectional study” or “rate” or “epidemiology” or “screening”) and (“China” or “Chinese” or “Hong Kong” or “Macau” or “Taiwan” or “Mongolia” or “Japan” or “Korea” or “East Asia” or “Eastern Asia”). In addition, the reference lists of all eligible articles as well as recently published GD/IGD-related meta-analyses and systematic reviews were manually searched to avoid missing any potential studies.

Inclusion and exclusion criteria

Studies that met the following criteria were included: (1) original studies written in English; (2) epidemiological studies conducted in East Asia (including mainland China, Hong Kong, Macau, Taiwan, Japan, South Korea, North Korea, and

Mongolia); (3) studies in which GD was defined clearly (i.e., involved gaming disorder, gaming addiction, or addictive gaming); (4) studies that reported the prevalence of GD; and (5) studies for which full text was available. Exclusion criteria were: (1) studies with incomplete data or repeated publication; (2) studies in which a GD-related screening or diagnostic scale was not adopted; and (3) studies involving a psychiatric sample.

Data extraction

Data were separately extracted by two authors using a pre-defined data-extraction sheet and were checked by a third author. The following information was extracted from the selected studies: authors' names, year of publication, country/region in which the research was conducted, sampling strategy (random sample or not), sample selection (general population or game players), sample size, mean age, proportion of male, assessment tools and their cut-offs, and the prevalence of GD. Longitudinal studies capture baseline data only; if one paper considers data from two or more countries/regions, data of each country/region are shown separately.

Quality evaluation

An 11-item checklist developed by the Agency for Healthcare Research and Quality (AHRQ) (Rostom et al., 2004) was used to assess the quality of included studies; the scale is recommended for quality evaluation of cross-sectional or observational studies (Zeng, Liu, & Chen, 2012). Answers for each item are 1 = "yes" or 0 = "no"/"unclear." Studies were classified according to the total score as follows: 8–11 = high quality, 4–7 = moderate quality, and 0–3 = low quality (Hu et al., 2015). Two authors scored eligible studies independently, and any disagreements were resolved by a discussion between the two authors, and a third author was consulted if the disagreements remained unresolved.

Statistical analyses

Stata version 16.0 (Stata Corporation, College Station, Texas, USA) was used to perform meta-analysis. The I^2 statistic was used to evaluate heterogeneity between studies. A value below 25% was considered to reflect a low likelihood of differences, 25%–75% indicated moderate likelihood, and 75%–100% represented a high level of heterogeneity (Higgins, Thompson, Deeks, & Altman, 2003). The reported prevalence was extracted and checked for accuracy by dividing the number of GD cases by the number of total participants in each study. A random effect model was used to calculate the overall GD prevalence and 95% confidence intervals (CIs) due to the high level of heterogeneity between studies ($I^2 = 99\%$).

Subgroup analyses were performed to determine how potential factors influenced the prevalence estimates by using available date. For example, the prevalence estimates were entered into Stata separately by gender if a study provided the prevalence for both males and females. Seven characteristics were considered potential influences: country (according to the region where the study was conducted), sample size (categorized into less than 1,000/more than 1,000), sample selection (categorized into gamer/general), sample strategy (categorized into random/not random), quality score (categorized into high/moderate/low), proportion of male (categorized into less than 50%/more than 50%), and assessment tool (DSM-5/others). In addition, meta-regression was performed according to the results of subgroup analysis to further ascertain the source of heterogeneity.

Publication bias was checked using the Egger's and Begg's tests, with $P < 0.05$ indicating the presence of publication bias. Sensitivity analysis was performed to determine the study that impacted the pooled estimates the most and to review the robustness of the estimates. For this step, each study was excluded sequentially to re-calculate pooled estimates multiple times, to ensure that no single study was driving the findings.

RESULTS

Literature search results

A total of 1,234 publications were identified using the aforementioned search strategy (PubMed = 255, Embase = 440, PsycINFO = 171, Cochrane = 7, and Web of Science = 361). Total 1234 publications were identified using the aforementioned search strategy. Next, 354 papers were excluded for duplicates, 765 for irrelevant titles and/or abstracts, and 5 that were conducted outside East Asian, leaving 110 eligible studies. Then 110 eligible studies and additional records identified through other source ($n = 1$) were conducted a full-text review against the inclusion and exclusion criteria. Out of 111 papers, of which 45 were not epidemiologic studies (etc. development and/or validation of the assessment tool) or did not report prevalence, 9 were no standard definition or cut-off for GD, 2 were psychiatric sample, 5 provided data for Internet addiction, 11 had insufficient data, and 17 were not available as full text. Finally, a total of 22 articles (26 studies) were included in the present meta-analysis (Fig. 1).

Narrative description of the studies included in the meta-analysis

Table 1 summarizes the characteristics of the studies included in the meta-analysis. The studies were conducted in China including Chinese mainland ($n = 8$), Hong Kong/Macao ($n = 6$) and Tai Wan ($n = 2$), South Korea ($n = 9$) and Japan ($n = 1$), none from the other two eastern Asian countries, and were published between 2014 and 2021. Altogether 51,525 participants were involved. There was a higher proportion of male in 14 studies, 19 studies had a large sample size (more than 1,000), 10 studies had a unique

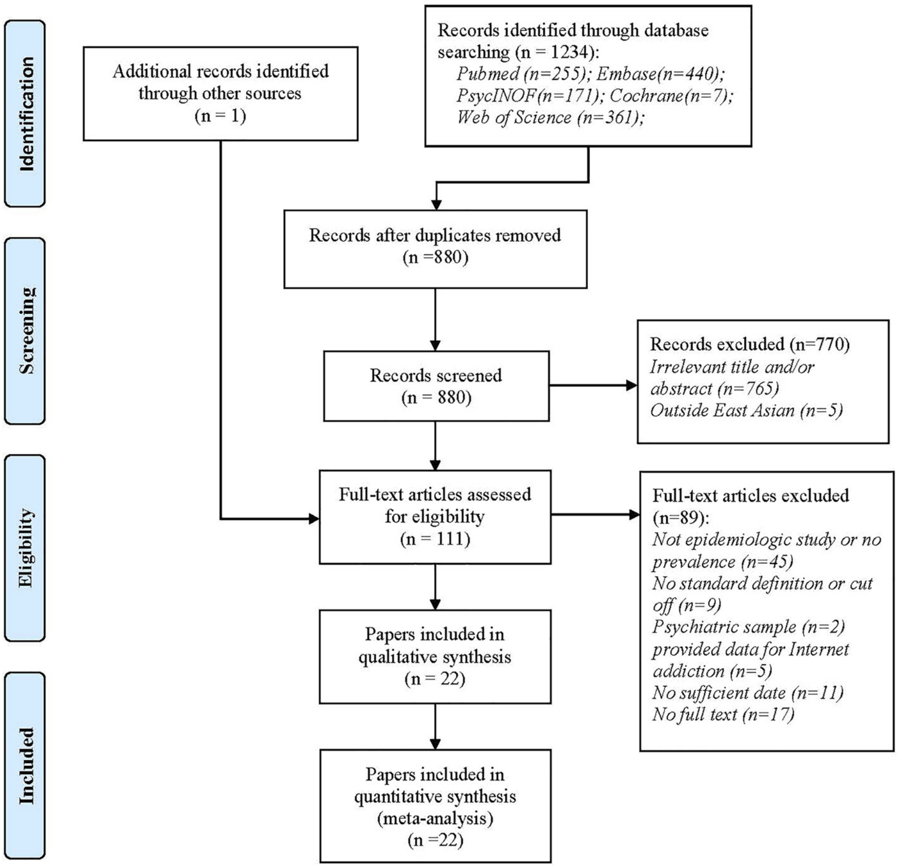

Fig. 1. Study selection flow diagram

sample selection (gamers), and eight studies adopted a random strategy. Most of the studies involved a population of adolescent and/or young adults, and six studies involved old adults.

Ten different assessment tool were used to identify addiction to gaming: the DSM-5 criteria was used in 10 studies, the Short Form of the Game Addiction Scale (GAS-SF) was used in two studies, the Internet Gaming Disorder Scale (IGDS) was used in one, the Scale of Problematic Game Playing (SPGA) was used in one; further, two studies used the 12-item Problematic Online Gaming Questionnaire-Short Form (POGQ-SF), one used the 11-item Chinese version of the Internet Gaming Disorder Questionnaire (CIGD), two used the Internet Gaming Use-Elicited Symptom Screen (IGUESS), one used the Chinese Gaming Disorder Scale (CGDS), one used the 9-item Internet Gaming Disorder Scale-Short Form (IGDS9), and one used the Video Gaming Dependency Scale (VGD-S). The choice of a cut-off point to identify addiction varied among the studies.

The Agency for Healthcare Research and Quality scale was used to evaluate the quality scores of the included studies, which ranged between four and nine. Nine studies were of high quality (8–9), 17 studies were of moderate quality (4–7), and none were of low quality.

Prevalence of GD

The heterogeneity test showed a result of I^2 = 99% ($P <$ 0.001), indicating a high level of heterogeneity between the studies. Thus, a random-effects model was chosen to calculate the pooled prevalence. Figure 2 shows the forest plot of the prevalence of GD, which varied from 1.2% to 21.1% across the 26 studies; the overall pooled prevalence was 12%, 95% CI (10%–15%), and this figure was adjusted to 6%, 95% CI (3%–9%) when considering only those studies that used more stringent sampling methods (using random strategy and among general population).

Subgroup and meta-regression analyses

Table 2 and Fig. 3 shows the results of subgroup analyses. There was a significant difference in GD prevalence between gender (Q = 13.3, $P < 0.05$). The prevalence of GD for male was 16%, 95% CI (13%–20%) and for female it was 8%, 95% CI (5%–11%) (Fig. 3). It was also statistically varied across sample selection (Q = 4.79, $P < 0.05$) and sample strategy (Q = 7.76, $P < 0.05$). The estimated prevalence was higher among gamers (13%) than the general population (10%), and those studies that used a random strategy presented a lower estimated prevalence

Table 1. Descriptive characteristic of the study included in the meta-analysis

Author, Year	Country/Region	Sampling strategy	Sample selection	Sample size	Mean age	Male (%)	Scale	Cut off	Prevalence (%) Total	male	female	QS
Wang et al. (2014)	HK	Random	Gamer	503	14.6	49.5	GAS-SF	3/7	15.7	22.7	8.7	9
Wang et al. (2015)	HK	Random	General	920	15.0	36.6	GAS-SF	7/7	13.0	27.9	4.5	8
Kim et al. (2016)	SK	Not random	Gamer	3041	NR	60.6	DSM-5	5/9	13.7	13.0	14.8	6
Yu et al. (2016)	SK	Random	General	2024	14.5	50.6	IGDS	5/9	5.9	10.4	1.2	8
Paik et al. (2017)	SK	Not random	Gamer	3058	27.0	50.6	DSM-5	5/9	12.9	14.2	11.6	7
Kim et al. (2017)	SK	Random	Gamer	1401	33.1	69.8	SPGA	4/8	7.7	7.4	8.3	8
Na et al. (2017)	SK	Not random	Gamer	2923	NR	71.4	DSM-5	5/9	16.9	17.2	16.2	7
Tang et al. (2017)	CM	Not random	General	1035	19.6	45.2	POGQ-SF	32/60	21.1	NR	NR	6
Tang et al. (2018)	CM	Not random	General	1090	NR	43.8	POGQ-SF	32/60	20.4	NR	NR	7
Tang et al. (2018)	HK/MC	Not random	General	838	NR	42.1	POGQ-SF	32/60	23.3	NR	NR	7
Tang et al. (2018)	TW	Not random	General	898	NR	50.1	POGQ-SF	32/60	17.6	NR	NR	7
Tang et al. (2018)	SK	Not random	General	968	NR	45.9	POGQ-SF	32/60	16.3	NR	NR	7
Tang et al. (2018)	JP	Not random	General	1015	NR	49.8	POGQ-SF	32/60	14.6	NR	NR	7
Wu, Chen, Tong, Yu, and Lau (2018)	MC	Random	General	1000	40.0	44.0	DSM-5	5/9	2.0	3.4	0.9	8
Wang et al. (2018)	SK	Not random	General	7200	NR	55.6	DSM-5	5/9	10.8	NR	NR	4
Wu, Lee, Liao, and Ko (2019)	TW	Random	General	2147	NR	49.6	DSM-5	5/9	1.2	NR	NR	6
Zhang et al. (2019)	MC	Not random	Gamer	469	19.3	41.6	DSM-5	5/9	14.8	30.4	8.0	8
Yang et al. (2020)	CM	Random	Gamer	2666	12.8	51.9	DSM-5	5/9	13.0	17.5	7.9	9
Lin et al. (2020)	CM	Not random	General	1089	11.3	52.9	CIGD	5/11	6.0	NR	NR	7
Han et al. (2020)	SK	Not random	Gamer	1532	NR	67.6	IGUESS	10/27	10.1	NR	NR	4
Jeong et al. (2020)	SK	Random	General	2319	NR	56.7	IGUESS	10/36	7.6	NR	NR	9
Yu et al. (2020)	CM	Not random	Gamer	1066	13.0	56.5	DSM5	5/9	13.6	NR	NR	7
Li et al. (2020)	CM	Not random	General	1127	20.1	42.4	CGDS	6/9	6.4	11.9	2.3	6
Liao et al. (2020)	CM	Not random	Gamer	6379	19.4	58.0	VGD-S	5/9	17.0	20.2	12.4	8
Wang et al. (2021)	HK	Not random	General	847	50.0	39.0	IGDS9	21/45	2.6	NR	NR	5
Yu, Mo, Zhang, Li, and Lau (2021)	CM	Not random	General	3075	NR	50.4	DSM5	5/9	13.5	19.2	7.8	7

Note: HK = Hong Kong; MC = Macao; TW = Tai Wan; CM = Chinese Mainland; SK = South Korea; JP = Japan; NR = Not report; GAS-SF = Short Form of the Game Addiction Scale; DSM-5 = Diagnostic and Statistical Manual of Mental Disorders. 5^{th}; IGDS = Internet Gaming Disorder Scale; SPGA = Scale of Problematic Game Playing; POGQ-SF = 12-item Problematic Online Gaming Questionnaire Short-Form; CIGD = 11-item Chinese version of the Internet Gaming Disorder Questionnaire; IGUESS = Internet Gaming Use-Elicited Symptom Screen; CGDS = Chinese Gaming Disorder Scale; VGD-S = Video Gaming Dependency Scale; IGDS9 = 9-item Internet Gaming Disorder Scale-Short Form; QS: Quality score.

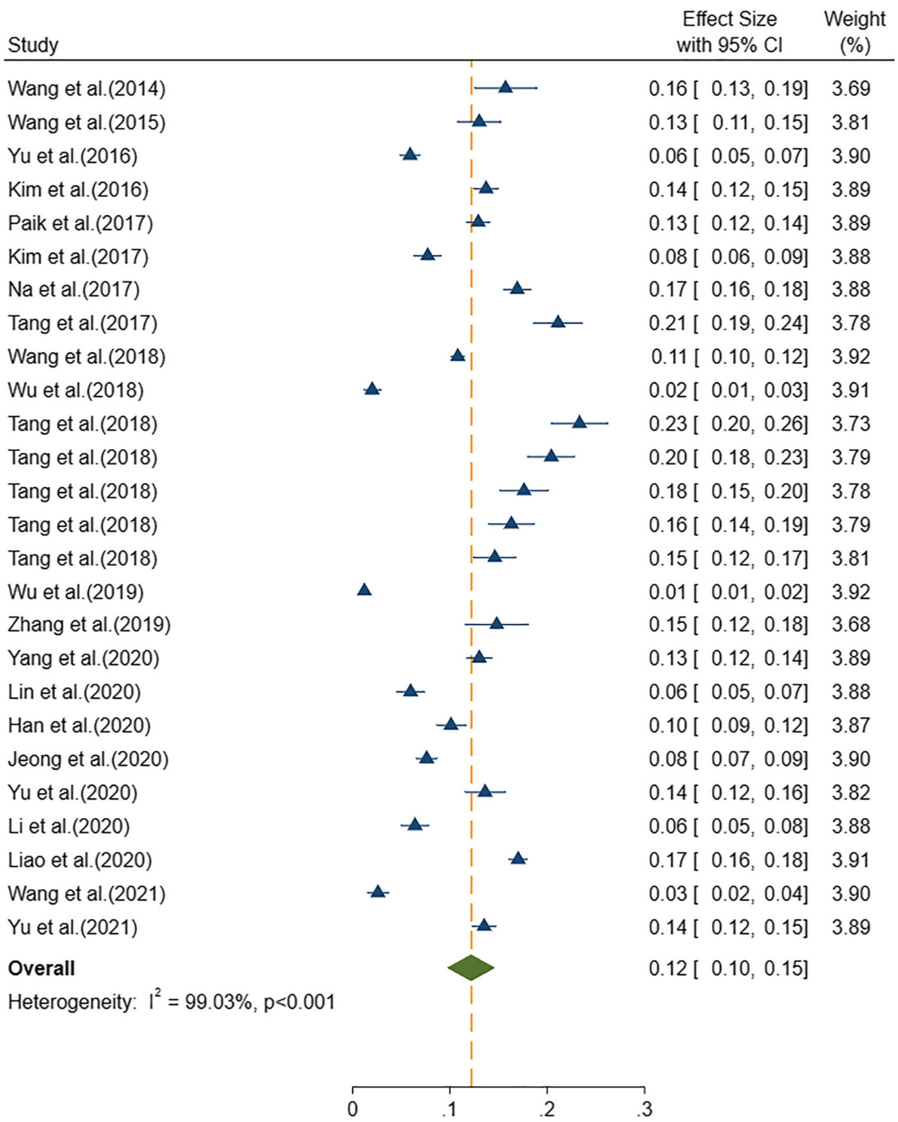

Fig. 2. Forest plot of the prevalence of GD

Table 2. Subgroup analyses

Subgroups	Categories (number of studies)	Prevalence (%)	95%CI (%)	*P* values within subgroups	Q (*P*) value across subgroups
Country/Region	Chinese Mainland (8)	14	10–17	<0.001	4.81 (0.31)
	Hong-Kong/Macao (6)	12	6–18	<0.001	
	Tai Wan (2)	9	7–25	<0.001	
	South Korea (9)	11	9–14	<0.001	
	Japan (1)	15	12–17	<0.001	
Sample size	≤1000 (7)	15	8–21	<0.001	0.94 (0.33)
	>1000 (19)	11	8–14	<0.001	
Sample selection	Gamer (10)	13	12–15	<0.001	4.79(0.03)
	General (16)	10	8–11	<0.001	
Sample strategy	Random (8)	8	5–11	<0.001	7.76(0.01)
	Not random (18)	14	12–16	<0.001	
Quality score	High (9)	11	7–15	<0.001	0.76 (0.38)
	Moderate (17)	13	10–16	<0.001	
Proportion of male	>50% (14)	12	10–14	<0.001	0.09 (0.77)
	≤50 (12)	13	9–16	<0.001	
Scale	DSM-5 (10)	10	7–14	<0.001	1.29 (0.26)
	Others (16)	13	10–16	<0.001	

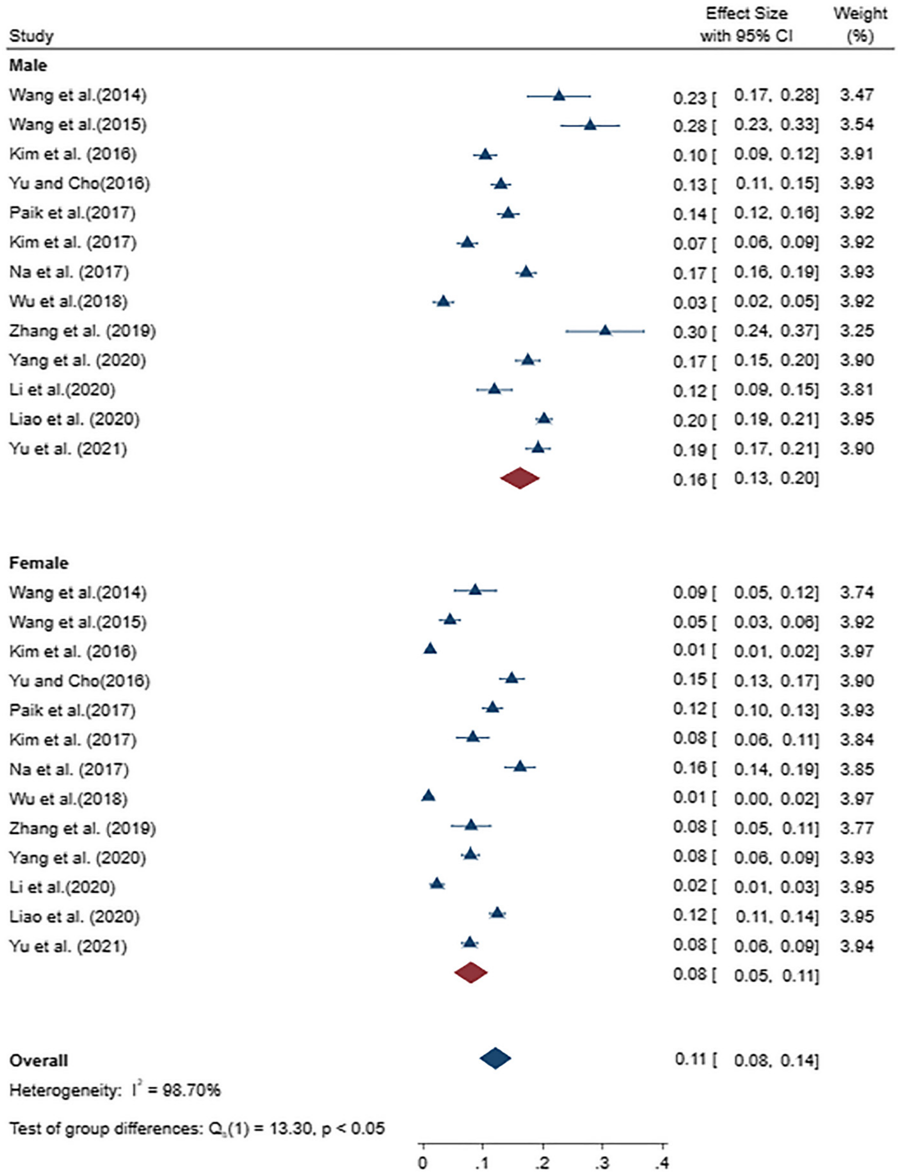

Fig. 3. Forest plot of pooled prevalence of GD by gender

(8%) than those that did not use a random strategy (14%). However, there was no significant difference between countries/regions (China Mainland: 14%; Hong Kong/ Macao: 12%; Tai Wan: 9%; South Korea: 11%; Japan: 15%. Q = 4.81, P = 0.31), sample size (less than 1,000 = 15% vs. more than 1,000 = 11%. Q = 0.94 P = 0.33), quality score (high quality = 11% vs. moderate quality = 13%. Q = 0.76, P = 0.38), proportion of males (more than 50% = 12% vs. less than 50% = 13%. Q = 0.09, P = 0.77) and scale (DSM-5 = 10% vs. others = 13%, Q = 1.29, P = 0.26).

Meta-regression analyses (R^2 = 54.54%, $P < 0.05$) revealed that sample selection (β = -0.05, $P < 0.05$) and sample strategy (β = 0.03, $P < 0.05$) was associated with the prevalence of GD. Those studies that adopted a non-random strategy and focused on the gamer population had a propensity to a higher estimated prevalence of GD. Additionally, we used quadratic curve fitting (Fig. 4) to display the association between mean age and prevalence of GD, and the results indicated that the prevalence rate increased initially and then decreased with the increase in age (R^2 = 38.90%, P = 0.06).

Publication bias and sensitivity analysis

The Egger's test (z = 4.58, $P < 0.05$) and the Begg's test (z = 1.68, $P > 0.05$) presented contradictory results, but experts recommend the primary use of the former; thus, publication bias may exist in this meta-analysis. After removing each study sequentially, the recalculated pooled prevalence did not change significantly, indicating that there was no outlier study that influenced the pooled results.

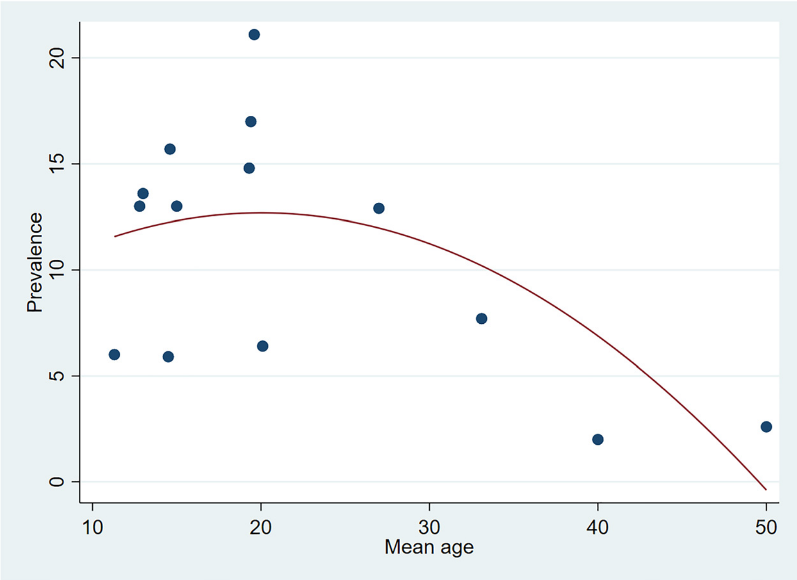

Fig. 4. Trend analysis between mean age and prevalence of GD

DISCUSSION

To the best of our knowledge, the present study is the first to estimate the prevalence of GD in East Asia. The salient findings were as follows: (1) the pooled prevalence of GD in East Asia was 12%, 95% CI (10%–15%), and this figure was adjusted to 6%, 95% CI (3%–9%) when considering only studies that met more stringent sampling criteria (using random strategy and among general population); (2) the GD prevalence was significantly higher among males than females (16% vs. 8%, respectively); and (3) studies among gamers and those without random sampling reported significantly higher prevalence rates. The results of the present meta-analysis are similar to a previous meta-analysis in Southeast Asia, 10.1%, 95% CI (3.4%–6.0%), which included 24 studies conducted in general population, with a higher prevalence in Singapore, 13.0%, 95% CI (9.8%–17.0%), than in Thailand, 5.7%, 95% CI (4.8%–6.7%) (Chia et al., 2020). However, this result was significantly higher than the figures in a global meta-analysis pooled from 17 different countries, 3.05%, 95% CI (2.38%–3.91%), while the figures for the three world regions (mixed sample selection and sample strategy) examined were: Europe 2.72%, 95% CI (1.96%–3.75%); America 2.74%, 95% CI (0.70%–10.21%); and Asia 5.08%, 95% CI (3.29%–7.78%) (Stevens et al., 2021), this meta-analysis only included 10 papers from Asia. Similarly, this result was higher than the figures reported for adolescents in a nationwide study, 4.6%, 95% CI (3.4%–6.0%), with the highest rate found for Asia, 9.9%, 95% CI (1.0%–21.5%), followed by North America, 9.4%, 95% CI (8.3%–10.5%), Australia, 4.4%, 95% CI (1.9%–7.4%), and Europe, 3.9%, 95% CI (2.8%–5.3%); this meta-analysis only included 2 studies from Asia (Fam, 2018). Consistent with findings in previous studies, the present study found that the pooled prevalence rates of GD in East Asia were higher than those in other world regions and comparable or slightly higher than those reported for Asia by other studies (Fam, 2018; Long et al., 2018; Stevens et al., 2021). This finding is plausible for several reasons. The first possible reason for these regional differences is the flourishing development of the gaming industry in East Asia. The 2021 Global Games Market Report stated that the Asia-Pacific region had the largest number of gamers in the world (55%, 1.615 billion) (Newzoo, 2021). Many top game developers, such as Nintendo, Capcom, Konami and Square Enix, come from East Asian countries. Therefore, it seems reasonable to observe a higher prevalence of GD in East Asia. Concurrently, that many top game developers are from Japan may be one of the reasons for the paucity of GD-related epidemiology research in Japan due to the conflict of interest. Second, almost half of the included studies were conducted among gaming players and more than half were from convenience samples. This may result in insufficient representation of the sample, likely raising the prevalence of GD; however, even considering the adjusted prevalence, the East Asian region is still more "vulnerable." In addition, the high male/female ratio (1.3:1) might lead to higher pooled prevalence of GD in this study, as the prevalence of GD was found to be significantly higher for males than for females (Mihara & Higuchi, 2017). Finally, there was a significant difference in GD rates between the studies that used different tools and cut-off scores. The high prevalence of GD rates in this study might relate to certain GD screening tools or the lower cut-off scores, the DSM-5 criteria seems more rigorous relative to other tool used in some studies.

The prevalence of GD varies from different study characteristics. Previous studies suggested that gender-related differences play an important role in the prevalence of GD (Wartberg, Kriston, & Thomasius, 2017; Wittek et al., 2016). Consistent with one previous meta-analysis, the results in this study showed that males were about twice as likely to experience GD than females (Stevens et al., 2021), but this proportion was significantly lower than that among adolescents (nearly four times) (Fam, 2018). Maladaptive cognitions were potential mediators between gender and GD (Yu, Mo, Zhang, Li, & Lau, 2021; Yu, Peng, et al., 2021). Furthermore, neural mechanisms and brain regions related to functional connectivity involved in executive control and reward processing that vary by gender might explain why males were more likely to develop GD (Dong, Wang, Wang, Du, & Potenza, 2019; Zeng et al., 2021). Future studies are warranted to develop gender-specific interventions to reduce GD.

Subgroup and meta-regression analyses both identified that gamer samples (13%) tended to report higher prevalence rates than general samples (10%). Additionally, non-random samples (14%) reported higher prevalence rates than random samples (8%). It was obvious that the representative sample (6%) was more likely to report lower prevalence rates of GD and the results in the representative sample were closer to the actual situation. Convenience sampling may result in inflated or overestimated prevalence. Further, sample size is another important factor that affected prevalence rates. In general, a small sample size usually leads to inaccurate prevalence estimation with a wide CI (Corty & Corty, 2011; Hajian-Tilaki, 2011). Tools for GD also have a significant impact on prevalence rate. However, the prevalence rates of GD were not statistically different when different types of tools were used (tools derived from the DSM-5 criteria or other tools). A plausible reason is that some studies did not use the DSM-5; instead, they used tools like VGD-S and IGDS, which were adapted from the DSM-5. A systematic review showed that although some tools had relatively greater evidential support for their psychometric characteristics, no single tool appeared clearly superior (Brand et al., 2020). Hence, there is an urgent need for large-scale research to accurately calculate the prevalence of GD in East Asia through representative sampling and the application of standardized tools. Moreover, no study in this meta-analysis used the ICD-11 to assess GD even though nine studies were published after 2020. Given the differences between the DSM-5 and the ICD-11 (Xiang et al., 2020), more research should be conducted using the ICD-11 to further explore the stability and reliability of GD.

Unsurprisingly, the results of a subgroup analysis showed that there were no significant difference in GD prevalence among mainland China (14%, 95% CI [10%–14%]), Hong Kong/Macao (12%, 95% CI [6%–18%]), Tai Wan (9%, 95% CI [7%–25%]), South Korea (11%, 95% CI [9%–14%]), and Japan (15%, 95% CI [12%–17%]). However, given the limited studies included in Tai Wan ($n = 2$) and Japan ($n = 1$), and the wide 95% CI of Hong Kong/Macao studies, we need to exercise caution in considering this result. In other words, the results from mainland China and South Korea seem more valid and reliable. This finding corresponds with previous epidemiological studies that showed that the prevalence of GD was quite high in both China and South Korea (Wang, Cho, & Kim, 2018; Yu, Mo, Zhang, Li, & Lau, 2021). According to the included studies, several factors can be taken into consideration for interpreting the high prevalence rates. Cultural context is a significant factor. Chinese and Asian cultures emphasize obedience and an authoritarian parenting style that might lead to the higher prevalence of GD (Yang et al., 2020). Positive parenting styles and non-violent communication skills among parents were recommended in interventions for adolescent GD. In contrast, the accessibility of the Internet, the abundance of Internet cafes, and the popularity of tablets and smartphones might explain the high rates of GD in these countries (Paik, Cho, Chun, Jeong, & Kim, 2017; Tang et al., 2018). Therefore, strong social norms and government regulations for Internet gaming are essential. In addition, Chinese university students have experienced specific challenges, such as becoming more independent and having a greater degree of autonomy and freedom of lifestyle which might contribute to their vulnerability to GD (Zhang, Wang, Yu, & Wu, 2019). The high prevalence of GD indicated the need to regulate gaming behaviors and conduct interventions to decrease GD in China and Korea. Furthermore, special attention should be paid to adolescents. The results of the present study also showed that the prevalence rate increased slowly during adolescence and declined around the age of 20, even if it was not statistically significant. Similar trends between age and prevalence rate of GD have been found in the previous studies (Lindenberg, Kindt, & Szász-Janocha, 2022). Adolescents seem to be particularly vulnerable to developing GD, and adolescent GD was positively associated with various behavioral and emotional problems (Brunborg, Mentzoni, & Frøyland, 2014; Lemmens, Valkenburg, & Peter, 2011).

This is the first meta-analysis to synthesize epidemiological literature on GD and comprehensively analyze prevalence-related GD studies in East Asia, and all of the included studies were rated as being of moderate or high quality. It also has several limitations. First, despite aiming for an estimate of the prevalence of GD in East Asia, not all East Asian countries/regions were represented because of the unavailability of data (no data available for North Korea and Mongolia and limited data from Japan and Tai Wan region). This may be attributed to the fact that we only included literature published in English. Second, while displaying the trend between age and prevalence of GD, we failed to explore the effects of age on the prevalence of GD in detail because of incomplete data. Third, the result of Egger's tests revealed publication bias. Studies with severe methodological shortcomings are usually difficult to get published, which may lead to publication bias. Finally, considering the high levels of heterogeneity between the included studies, there might be other potential associated factors that have not been examined.

CONCLUSIONS

The prevalence of GD in East Asia was found to be 12%, 95% CI (10%–15%), and this figure was adjusted to 6%, 95% CI (3%–9%) when considering only studies that met more stringent sampling methods (using random strategy and among the general population). Additionally, men were twice as likely to experience GD compared to women, which meant men were more vulnerable to GD. The prevalence of GD in East Asia appears to be higher than that in other regions. The results also indicated that sample selection and sample strategy influenced GD prevalence and may be the most important factors influencing the estimated prevalence of GD. As varied methodological approaches employed in GD studies affected the comparability of results, the findings of this study should be interpreted with caution. Large-scale research that meets more stringent sampling criteria should be conducted to investigate the prevalence of GD more accurately. Furthermore, given the differences in cultural backgrounds between countries and regions, future studies should extend such epidemiological research to other regions to calculate the accurate prevalence of GD to benefit the local identification, prevention, policy making and treatment efforts. Considering the negative effects and high prevalence of GD, effective measures for the prevention and treatment of GD in East Asia need greater attention.

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