

Burden of gaming disorder among adolescents: A systemic review and meta-analysis

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ABSTRACT

Objectives: Integrating digital technology into daily life has made video games a primary form of entertainment for adolescents worldwide. Despite their benefits, excessive gaming has emerged as a significant public health issue, recognized as a gaming disorder by the World Health Organization in the ICD-11. This study aims to assess the prevalence of gaming disorders among adolescents through a systematic review and meta-analysis.

Study design: Systematic review and meta-analysis.

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Methods: A search was conducted across multiple databases until February 15, 2024. Observational studies that assessed the prevalence of gaming disorder were included. Nested Knowledge software was used for screening and data extraction. The quality assessment was performed using the Joanna Briggs Institute tool. Meta-analysis using a random effect model was used to synthesize prevalence rates. Statistical analyses were performed in R software version 4.3.

Results: The meta-analysis included 84 studies covering a diverse geographical scope totaling 641,763 individuals. The pooled prevalence of gaming disorder was 8.6 % (95 % CI: 6.9 %–10.8 %), ($I^2 = 100$ %). Subgroup analysis revealed varying prevalence rates by country, with China reporting the highest rate at 11.7 % (95 % CI: 8.6 %–15.7 %). Meta-regression analysis highlighted an increasing trend in the prevalence of gaming disorder over the years, underscoring the growing impact of digital technologies.

Conclusion: A significant prevalence of gaming disorder among adolescents is observed. With an increasing trend, fostering healthy gaming habits, enhancing awareness, and implementing effective intervention programs are crucial. This emphasizes the importance of global efforts in combating the growing challenge of gaming disorder among adolescents.

1. Introduction

Digital technology has seamlessly integrated into every aspect of human life in recent years, with video games emerging as a dominant form of entertainment among adolescents worldwide [1–3]. These games serve as a source of entertainment and offer educational and social benefits, fostering cognitive skills, strategic thinking, and teamwork [4]. However, the flip side of this digital revolution has been the emergence of excessive gaming [5]. Such excessive engagement has raised significant concerns about its potential adverse effects on mental health and social well-being, catalyzing a global debate among healthcare professionals, educators, and policymakers [6,7]. The recognition of gaming disorder as a significant public health issue marks a critical point in this ongoing discussion. In 2018, the World Health Organization (WHO) officially recognized gaming disorder in the 11th Revision of the International Classification of Diseases (ICD-11) [8], describing it as a pattern of persistent or recurrent gaming behavior so severe that it takes precedence over other life interests and daily activities, despite the occurrence of negative consequences [9].

The burgeoning prevalence of gaming disorder, particularly among adolescents, is alarming [10]. This age group is at a critical developmental stage marked by significant psychological, social, and physical changes [11]. The compulsive use of video games during this vulnerable period can have profound implications, potentially stalling or derailing these developmental processes [12]. The resultant negative outcomes, such as increased anxiety, depression, social isolation, and poor academic performance, are not only immediate concerns but also pose long-term risks for mental health and social integration [13,14]. Furthermore, the immersive nature of today's video games, combined with the social and competitive aspects facilitated by online platforms, can exacerbate these effects, making it increasingly difficult for affected individuals to disengage [15,16].

Understanding the epidemiological burden of gaming disorder and its impact on youth globally is paramount. A complex interplay of psychological, social, and environmental factors influences adolescents' engagement with digital gaming environments [17,18]. The digital age has brought about unprecedented access to gaming, with smartphones and portable gaming devices facilitating constant connectivity. This accessibility, coupled with the social validation found in online gaming communities, can contribute to the compulsive nature of gaming behaviors [19]. Moreover, the heterogeneity in the recognition and diagnosis of gaming disorder, stemming from varying cultural attitudes towards gaming and differing healthcare frameworks, complicates the global response to this issue. Recognizing the signs of gaming disorder early, fostering healthy gaming habits, and promoting alternative activities that support adolescents' development are crucial steps [20].

Despite the growing body of literature on gaming disorder, there remains a need for a comprehensive synthesis of evidence to understand its global prevalence, risk factors, and health consequences among adolescents. Variability in study methodologies, definitions of gaming

disorder, and population characteristics have resulted in a wide range of prevalence estimates and outcomes, making it challenging to draw generalizable conclusions. A systematic review and meta-analysis can address these challenges by aggregating data from multiple studies, providing a more accurate estimation of the burden of gaming disorder and identifying patterns and gaps in the current research landscape.

This study aims to conduct a systematic review and meta-analysis to evaluate the burden of gaming disorder among adolescents. By examining the prevalence, this study seeks to provide a comprehensive overview of the current state of research, offer insights into the global impact of gaming disorder on adolescent health, and suggest directions for future research and interventions.

2. Methods

The study design of the present study is systematic review and meta-analysis. This study followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Table S1) [21]. Nested Knowledge web software (Nested-Knowledge, MN, USA) was used for screening and data extraction. The Protocol has been registered in International Prospective Register of Systematic Reviews (PROSPERO) under the register number: CRD42024512385.

2.1. Eligibility criteria

Studies were eligible for inclusion if they were observational in nature, and if they assessed the prevalence of gaming disorder using any recognized diagnostic criteria, such as the DSM-5 or ICD-11. Any other standard scales were also considered. Additionally, these studies needed to report specifically on adolescent populations, defined as individuals between 9 and 21 years, and be published in English. Exclusions were applied to reviews, commentaries, and any studies that did not contain primary data. Table S2 shows the eligibility criteria.

2.2. Search strategy

An experienced librarian searched databases up to January 10, 2024 with subsequent update on February 15, 2024, including PubMed, EMBASE, and Web of Science, for articles published from 2000 to the search date. The search strategy employed a combination of keywords related to gaming disorders, such as "internet gaming," "problematic gaming," "addictive gaming," and "gaming disorder," along with terms targeting the adolescent demographic, including "adolescents," "teenage population," "young individuals," and "juveniles." Initially, there were no restrictions on the publication date or language. However, subsequent filtering was applied to select only articles published in English. The search strategies were customized to match each database's unique syntax and requirements (Table S3).

2.3. Study selection

Two reviewers (PS, MNK) independently conducted the screening process, initially reviewing titles and abstracts for eligibility, followed by a comprehensive full-text review of the potentially relevant articles. Any disagreements encountered during the screening process were resolved through discussion or, if necessary, by consulting a third reviewer (AMG). This screening was executed in two distinct phases: first, the screening of titles and abstracts, and subsequently, the full-text screening of selected articles. The Nested Knowledge Web software facilitated the screening process, ensuring a structured and efficient review [22,23].

2.4. Data extraction and quality assessment

A standardized data extraction form was employed to gather specific details from each study, such as the author(s), year of publication, country of origin, study design, sample size, age range of participants, mean age, diagnostic criteria used for gaming disorder, and the number of adolescents diagnosed with gaming disorder. Two reviewers (PS, MNK) independently performed the data extraction process to ensure accuracy and reliability. Any discrepancies that arose during this process were settled through consensus between the reviewers. The tagging function of Nested Knowledge software was utilized to facilitate and streamline the data extraction process [23].

The quality of the studies included in this review was rigorously evaluated using the Joanna Briggs Institute (JBI) tool for assessing the

quality of prevalence studies [24]. This comprehensive tool is designed to appraise various aspects of study design, methodology, and reporting, thoroughly examining the potential biases and the reliability of the findings reported in each study.

2.5. Statistical analysis

A random-effects meta-analysis was employed to synthesize prevalence rates of gaming disorder among adolescents from the collected data, which allowed for the consideration of between-study heterogeneity. This heterogeneity was quantified using the I^2 statistic and tau estimator [25,26]. Furthermore, subgroup analyses were planned to explore variations by country. Meta-regression analyses were performed to examine the association between study-level variables (e.g., publication year, age, and sample size) and the prevalence of gaming disorder. A Doi plot was utilized to assess the potential for publication bias [27,28]. Sensitivity analyses were performed using a leave-one-out approach to ensure the robustness of the results [29]. A 95 % prediction interval was calculated to provide a range within which the true effect size is expected to lie in similar future studies [30]. All statistical analyses were performed using the "meta" and "metaphor" packages in R software, version 4.3 [31].

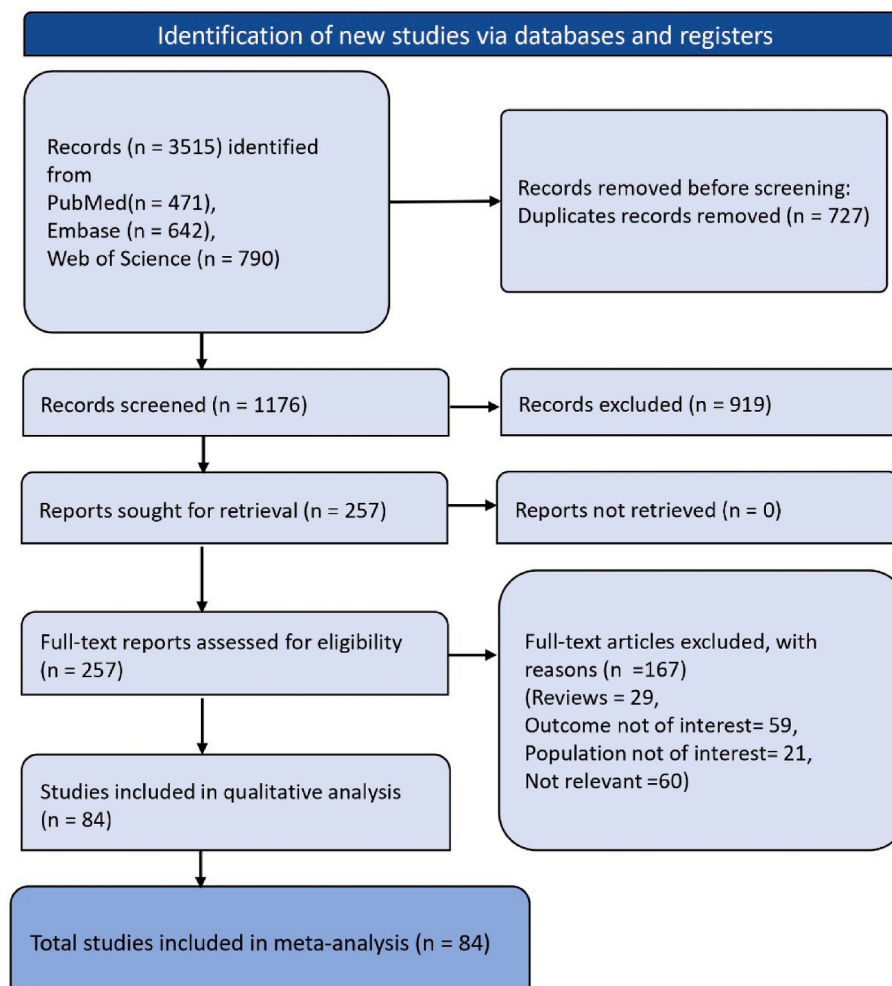


Fig. 1. PRISMA flowchart depicting article selection process.

3. Results

3.1. Literature search

The search across multiple databases yielded a total of 3515 records. Initial screening led to the removal of 727 duplicate records. After this step, 1176 records were screened for relevance, excluding 919 records that did not meet the inclusion criteria. These records underwent a full-text assessment for eligibility, which led to a further exclusion of 167 records based on specific reasons: 29 were reviews, 59 did not pertain to the outcome of interest, 21 involved populations not of interest, and 60 were deemed not relevant to the research question. Following the full-text assessment, 84 studies were included in the meta-analysis (Fig. 1).

3.2. Characteristics of included studies

The characteristics of the included studies are summarized in Table 1. These studies predominantly utilize a cross-sectional design, although a handful employ longitudinal and prospective designs, highlighting a focus on immediate associations and the potential for long-term patterns relating to gaming disorder. Thirty-two studies were conducted in China [32–63], demonstrating a substantial regional research focus. Spain contributed 5 studies [64–68], and the United States contributed two studies [69,70], respectively. Notably, Sweden [71–73], and the Netherlands [74–76] have each contributed three studies, indicating a keen research interest in Europe. Germany [77,78], Finland [74–76] and Korea [79,80] both have two studies. Saudi Arabia is represented with three studies [81–83], illustrating growing attention in the Middle East. Australia contributed three studies [9,84,85]. Six studies were conducted in multiple European countries [86–91]. Countries like Taiwan [92], Ireland [93], Vietnam [94], Israel [95], Tunisia [96], Lebanon [97], Egypt [98], Iran [99], Malaysia [100], Kyrgyzstan [101], Norway [102], Brazil [103], Croatia [104], Indonesia [105], and Turkey [106] each contributed one study, showcasing the worldwide interest in the prevalence of gaming disorder among adolescents.

The age range of participants in these studies varies, with some focusing on a narrower spectrum, such as 12–18 years, while others encompass a broader range from 8 to 21 years. Mean ages across the studies typically fall within the early to mid-teen years, mirroring the adolescent-centric focus of the research. Sample sizes demonstrate considerable variability, ranging from as few as 76 participants to as many as 63,205, enabling a broad investigation into the prevalence and criteria of gaming disorder.

The criteria employed to assess gaming disorder are diverse, with many studies using established measures like the 20-item Internet Gaming Disorder Assessment (IGDA), the Game Addiction Scale (GAS) short version, and the DSM-5 criteria. Others have opted for custom questionnaires or less common scales, revealing different approaches to defining and measuring gaming disorder. The proportion of adolescents diagnosed with gaming disorder shows notable variation, which may be attributed to cultural, methodological, and criteria-related differences across studies. The quality assessment of the studies is given in Table S4.

3.3. Prevalence of gaming disorder among adolescents

We performed a meta-analysis to determine the pooled prevalence of gaming disorders among adolescents (Fig. 2). The analysis incorporated data from a wide range of studies, yielding a total sample size of 641,763 individuals. Based on the random effects model the pooled prevalence estimates of gaming disorder was found to be 8.6 % (95 % CI: 6.9 %–10.8 %). The prediction interval, which estimates where the true prevalence might fall in similar but yet-to-be-studied populations, ranged from 1.0 % to 48.1 %. It should be noted that the heterogeneity across the included studies was high ($I^2 = 100$ %).

3.4. Country-wise prevalence

We conducted a group analysis to estimate the country's prevalence of adolescent gaming disorders (Fig. S1). The subgroup analysis revealed significant trends in the prevalence of gaming disorder among adolescents, with marked differences across various countries (Table 2). China led the data with the most considerable number of studies [32] and the largest sample size (170,526), showing a substantial prevalence rate of 11.7 % (95 % CI: 8.6 to 15.7). This suggests a significant impact of gaming disorder on its youth population. Spain's five studies revealed a notable prevalence of 9.6 % (95 % CI: 2.2 to 33.2), indicating that gaming disorder is also a significant concern in European countries. A remarkable finding across the studies was the high degree of heterogeneity; several countries exhibited nearly complete heterogeneity (I^2 close to or at 100 %). This points to considerable variability in prevalence estimates across different populations, possibly due to varied methodologies. Countries with a single study, such as Egypt and Iran, reported very high prevalence rates of 61.3 % (95 % CI: 57.6 to 64.9) and 33 % (95 % CI: 31.6 to 34.6), respectively. These figures suggest that gaming disorder could be an under-researched area in these regions. On the other hand, countries with multiple studies like Sweden, with three studies reporting a prevalence of 9.5 % (95 % CI: 0.5 to 69.2), and the Netherlands, with three studies and a prevalence of 3.7 % (95 % CI: 0.6 to 19.9), still showed significant heterogeneity, which implies that substantial differences in findings can exist even within countries with more research data.

3.5. Sensitivity analysis

Sensitivity analysis was conducted to evaluate the influence of individual studies on the pooled prevalence rate of gaming disorder among adolescents (Fig. S2). This analysis involved the systematic omission of each study to observe the effect on the overall meta-analytic estimate. The findings demonstrated that the pooled prevalence remained stable across the analyses, indicating that no single study unduly influenced the meta-analytic results. The recalculated proportions and 95 % confidence intervals were consistent with the overall pooled prevalence rate when all studies were included, affirming the robustness of our meta-analysis.

3.6. Meta-regression

A meta-regression analysis was performed to determine the effects of mean age, sample size, and year of publication on the prevalence rate of gaming disorder among adolescents. It was found that neither mean age ($p = 0.71$) nor sample size ($p = 0.65$) was significantly associated with prevalence rates. However, a significant positive association was noted with the year of publication ($p = 0.016$), suggesting that more recent studies tend to report higher rates of gaming disorder. The accompanying bubble plot (Fig. 3) illustrates this meta-regression based on the year of publication. The size of the bubbles corresponds to the weight of each study, and the plotted regression line indicates an ascending trend in the prevalence of gaming disorder over the years. Despite some variability, the general direction points to an increasing prevalence in more recent times, highlighting the escalating concern regarding gaming disorder among the youth as we move forward.

3.7. Publication bias

Our assessment for publication bias using the Doi plot revealed an LFK index of -1.47 (Fig. 4). This value, being outside the acceptable range of -1 to $+1$, suggests the presence of asymmetry and hints at potential publication bias in our meta-analysis. The plot depicts a visual assessment of this bias, with the distribution of studies suggesting that smaller studies with less favorable outcomes may be underrepresented. However, given the limitations of visual assessments, we corroborated

Table 1
Characteristics of included studies.

Study	Country	Study Design	Age range	Mean age	Sample Size	Adolescents with Gaming disorder	Criteria used for assessing gaming disorder
Alfaifi 2022 [81]	Saudi Arabia	Cross-sectional	12 and 18 years	NA	450	132	20-item IGDA
Amudhan 2022 [111]	India	Cross-sectional	11 and above	12.58	1729	447	GAS - Short Version
André 2022 [71]	Sweden	Cross-sectional	8–18 years	NA	144	47	Game Addiction Scale for Adolescents
Bumozah 2023 [82]	Saudi Arabia	Cross-sectional	16.91	16.91	400	76	IGDS9-SF
Buren 2023 [86]	European countries	Cross-sectional	15 years	15	626	50	GSMQ-9
Castren 2022 [112]	Finland	Cross-sectional	15–16 years	NA	4160	551	Custom Questionnaire
Chang 2022 [32]	China	Cross-sectional	13–21 years	15.2	1305	53	IGDS- 9
Chen 2023 [45]	China	Longitudinal study	10 to 18	NA	2148	277	DSM-5, GAS-7
Chiu 2018 [92]	Taiwan	Cross-sectional	10–18 years	13.17	76	8	DSM-5, IGDT-10
Colasante 2022 [87]	European countries	Cross-sectional	15–16 years	NA	88998	17,800	Perceived problem scale (PPS)
Colder Carras 2018 [88]	European countries	Cross-sectional	14–18 years	15.8	13,460	403	AICA-S
Columb 2021 [93]	Ireland	Cross-sectional	12–18 years	14.2	234	4	IGDS9-SF
Cuong 2022 [94]	Vietnam	Cross-sectional	NA	14.5	2084	242	IGD-20 Test
Desai 2010 [69]	USA	Cross-sectional	14–18 years	NA	4028	197	Minnesota Impulse Disorder Inventory
Efrati 2023 [95]	Israel	Prospective study	13 to 18	15.77	1056	23	IGDS9-SF
Esteve 2022 [64]	Spain	Cross-sectional	13 and 17 years	NA	397	65	GASA
Fekih-Romdhane 2023 [96]	Tunisia	Cross-sectional	21.26 ± 1.68 years	21.26	851	212	DSM-5, IGD-20
García-Gil 2023 [65]	Spain	Cross-sectional	12–18 years	14.5	1448	469	VGEQ
Gerdner 2022 [72]	Swedish	Cross-sectional	12–18 years	NA	387	9	IGDS
Greenberg 2022 [70]	USA	Cross-sectional	NA	NA	3657	79	Minnesota Impulsive Disorders Inventory
Haagsma 2013 [74]	Netherlands	Longitudinal study	12–22 years	15.7	810	16	DSM-IV, GAS
Hawi 2018 [97]	Lebanon	Cross-sectional	15–19 years	16.2	524	48	DSM-5, IGD-20
Hing 2023 [84]	Australia	Cross-sectional	12–17 years	14.8	646	89	IGDS9-SF
Huang 2022 [46]	China	Cross-sectional	9–18 years	NA	10,479	334	IGDS9-SF
Jo 2020 [79]	Korea	Cross-sectional	13–18 years	13.14	139	51	DSM-5
Junus 2023 [47]	China	Cross-sectional	11–17 years	NA	1510	86	IGDS9-SF
Kewitz 2021 [77]	Germany	Cross-sectional	11–17 years	NA	177	7	CSAS
Khalil 2022 [98]	Egypt	Cross-sectional	14–18 years	16.1	700	429	IGD Scale
Kim 2020 [80]	Korea	Cross-sectional	12–18 years	NA	2,23,542	20,797	Internet Addiction Proneness Scale for Youth-Short Form (KS scale)
Kim 2022 [113]	Australia	Longitudinal study	13–14 years	13.7	4968	770	IGD scale
King 2017 [9]	Australia	Cross-sectional	12–17 years	14.1	799	25	IGD-checklist
Lan 2022 [85]	Taiwan	Cross-sectional	10–18 years	15.4	8446	109	NA
Liang 2019 [48]	China	Cross-sectional	9–16 years	11.63	2423	72	IGD Questionnaire
Lin 2023 [49]	China	Cross-sectional	13.5 years old	13.5	4835	813	DSM-5, GAS-7
Lin 2023 [99]	Iran	Cross-sectional	16.02 ± 1.40	16.02	3837	1268	DSM-5, GDT
Liu 2023 [50]	China	Longitudinal study	12.33–15.33 years	13.18	910	107	IGDS
Luo 2021 [51]	China	Cross-sectional	12–19 years	15.61	28,689	1322	IGDS9-SF
Ma 2021 [52]	China	Cross-sectional	15–18 years	16.5	200	86	ICD-11 diagnostic guidelines for GD
Machimbarrena 2023 [66]	Spain	Cross-sectional	11–18 years	14.2	2024	66	IGD-20
Macur 2021 [114]	Slovenia	Cross-sectional	12–16 years	13.44	1071	48	IGDS9-SF
Männikkö 2020 [115]	Finland	Cross-sectional	12–16 years	13.9	560	5	POGQ
Mohamed 2023 [100]	Malaysia	Cross-sectional	13 years and above	NA	5290	185	IGDS9-SF
Muhametjanova 2023 [101]	Kyrgyzstan	Cross-sectional	11–21 years	17.7	195	16	IGD-10
Müller 2015 [89]	European countries	Cross-sectional	14–17 years	15.8	12,938	209	DSM-5, AICA-S
Myrseth 2018 [102]	Norway	Longitudinal study	aged 17.5years	17.5	2055	24	GASA
Nogueira-López 2023 [67]	Spain	Cross-sectional	11 and 18 years old	13.81	41507	747	PIUS-A
Olsen 2024 [73]	Sweden	Cross-sectional	9–15 years	12	541	48	DSM
Ong 2016 [53]	China	Retrospective cohort study	Aged 19 and below	15.48	260	77	Problematic Internet Use Questionnaire
Peeters 2019 [75]	Netherlands	Longitudinal study	12–16 years	13.3	3348	83	DSM-5, IGDS
Peng 2023 [54]	China	Cross-sectional	14.3 years old	14.3	63205	1813	DSM-5, IGDS9-SF
Pontes 2016 [116]	Slovenia	Cross-sectional	12–16 years	13.44	1071	27	IGDS9-SF
Rajab 2020 [83]	Saudi Arabia	Cross-sectional	10–19 years	16.1	2537	126	GAS
Rikkers 2016 [117]	Australia	Cross-sectional	11–17 years	NA	2967	127	EU Kids Online Survey
Roza 2023 [103]	Brazil	Longitudinal cohort study	NA	10.2	1557	192	GAS-7
Sánchez-Llorens 2023 [68]	Spain	Cross-sectional	NA	NA	119	23	GASA
She 2022 [55]	China	Cross-sectional	NA	13.6	3136	1368	Problem Behaviour Scale
Šincek 2017 [104]	Croatia	Cross-sectional	11–21 years	14.44	1150	71	Problematic Online Gaming (POGQ)
Siste 2022 [105]	Indonesia	Cross-sectional	20.3 to 1.9	20.3	1233	23	IGDT-10

(continued on next page)

Table 1 (continued)

Study	Country	Study Design	Age range	Mean age	Sample Size	Adolescents with Gaming disorder	Criteria used for assessing gaming disorder
Spilková 2017 [90]	European countries	Cross-sectional	NA	16.7	4887	535	ESPAD study questionnaire
Thakur 2023 [118]	India	Cross-sectional	12–19 years	15.01	707	5	IGDS9-SF
Tsui 2021 [56]	China	Cross-sectional	10–17 years	13.23	1099	44	Korean Internet Addiction Proneness Scale
Uçur 2021 [106]	Turkey	Cross-sectional	12 and 18	14.7	1291	144	GAS
Van Den Eijnden 2018 [76]	Netherlands	Longitudinal study	12–15 years	12.9	538	53	IGD scale, DSM-5
Van Der Neut 2023 [91]	European countries	Cross-sectional	NA	13.47	14,398	1283	IGDS
Wang 2014 [57]	China	Cross-sectional	NA	14.58	503	79	DSM-5, GAS
Wang 2023 [58]	China	Cross-sectional	13–15 years	NA	2902	408	DSM-5IGD, (DISCA)
Wartberg 2023 [78]	Germany	Cross-sectional	15–19 years	16.84	480	53	IGD scale
Wei 2023 [59]	China	Cross-sectional	12 to 18	14.9	1494	356	POGQ-SF
Xie 2023 [60]	China	Cross-sectional	12–17 years	14.09	1906	327	IGA questionnaire
Xu 2023 [61]	China	Cross-sectional	9–18 years	NA	10,479	334	IGDS9-SF
Yang 2020 [62]	China	Cross-sectional	NA	12.77	2666	346	IGDS9-SF
Yang 2023 [63]	China	Cross-sectional	under 18 years	14.79	110	45	IAT, DSM-IV
Yang 2023 [33]	China	Cross-sectional	NA	13.9	2102	268	24-item IGCS
Yang 2023 [42]	China	Longitudinal study	10–18 years	14.36	459	151	SAS-SV scores
Yu 2019 [43]	China	Cross-sectional	12–17 years	13.59	500	27	Problematic Online Gaming (POGQ)
Yu 2020 [44]	China	Cross-sectional	NA	13	1066	145	DSM-V
Yu 2021 [34]	China	Cross-sectional	NA	NA	3087	418	9-item DSM-5
Yu 2022 [35]	China	Cross-sectional	10–18 years	NA	2503	444	15-item Chinese version of the Revised IGCS, DSM-5
Yu 2022 [36]	China	Cross-sectional	NA	13.1	2573	337	IGDS9-SF
Zhang 2022 [37]	China	Cross-sectional	12–18 years	9.48	7790	1777	VGDS
Zhang 2023 [38]	China	Cross-sectional	12–18 years	14.98	5988	582	DSM-5, GDSQ-21
Zhang 2023 [39]	China	Cross-sectional	16–19 years	16.89	283	45	DSM-5
Zhu 2021 [40]	China	Cross-sectional	8–17 years	12.6	2863	153	GAS-7
Zou 2022 [41]	China	Cross-sectional	11–16 years	13.58	1053	81	11-item Internet Gaming Addiction Scale

Abbreviations: AICA-S: Assessment of Internet and Computer game Addiction-Scale, DSM-IV: Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, DSM-5: Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, DSM-V: ESPAD: European School Survey Project on Alcohol and Other Drugs, GAS: Gaming Addiction Scale, GASA: Gaming Addiction Scale for Adolescents, GDT: Gaming Disorder Test, GSMQ-9: Game Social Media Questionnaire-9, IAT: Internet Addiction Test, ICD-11: International Classification of Diseases, Eleventh Revision, IGCS: Internet Gaming Cognition Scale, IGDA: Internet Gaming Disorder Assessment, IGD-10: Internet Gaming Disorder Scale-10, IGD-20: Internet Gaming Disorder Scale-20, IGDS: Internet Gaming Disorder Scale, IGDS9-SF: Internet Gaming Disorder Scale-Short Form (9 items), IGDT-10: Internet Gaming Disorder Test-10, IGS: Internet Gaming Scale, NA: Not Applicable or Not Available, POGQ: Problematic Online Gaming Questionnaire, POGQ-SF: Problematic Online Gaming Questionnaire-Short Form, PPS: Perceived Problem Scale, SAS-SV: Self-Rating Anxiety Scale-Short Version, VGDS: Video Game Dependency Scale, VGEQ: Video Game Engagement Questionnaire.

these findings with Egger’s test, which did not show statistical evidence of publication bias ($p = 0.1857$). These results suggest that while the Doi plot indicates potential bias, it is not statistically significant in our analysis.

4. Discussion

The systematic review and meta-analysis conducted in this study provide a comprehensive assessment of the burden of gaming disorder among adolescents. Our findings corroborate the significant prevalence of gaming disorder, evidenced by a pooled prevalence rate of 8.6 %. This rate reflects a substantial public health concern, given the negative consequences associated with excessive gaming, such as social isolation, academic difficulties, and mental health issues, such as anxiety and depression. The prevalence observed in our study is concerning but consistent with the emerging recognition of gaming disorder as a distinct psychopathology that merits attention from clinicians and policymakers alike. The high degree of heterogeneity observed across studies in our meta-analysis indicates a considerable variation in prevalence rates, which could be attributed to differences in cultural contexts, diagnostic criteria, and methodological approaches. This suggests that gaming disorder is perceived and reported differently across countries, which may influence the overall understanding of the disorder’s impact on adolescent populations. For example, the significantly higher prevalence rates reported in studies from Egypt and Iran point to possible regional nuances in the manifestation or reporting of gaming disorder. However, due to the limited number of studies from these countries, further

research is warranted to explore these regional differences comprehensively. Our subgroup analysis by country revealed that China has the most substantial body of research on gaming disorder, with a prevalence rate of 11.7 %. This is indicative of the country’s recognition of the issue and the measures being taken to address it. In contrast, Sweden and the Netherlands reported lower prevalence rates, yet the high heterogeneity suggests a complexity within these populations that cannot be overlooked. The variability in findings, even within countries with multiple studies, underscores the need for standardized diagnostic criteria and study methodologies to enable more accurate comparisons and conclusions. The ascending trend in the prevalence of gaming disorder over the years, as indicated by our meta-regression analysis, raises concerns about the increasing engagement of adolescents with digital gaming environments. The significant positive association with the year of publication ($p = 0.016$) implies that the disorder’s prevalence is growing, a trend that must be monitored closely given the rapid evolution of digital technologies and gaming platforms. This increasing trend also highlights the integration of digital technology into daily life has had profound effects on adolescents, with gaming emerging as a significant leisure activity. It was found that neither mean age nor sample size significantly influenced the prevalence rates, suggesting that gaming disorder affects a broad age range of adolescents and is not constrained to particular sample sizes or study designs. A prior meta-analysis assessing the prevalence of gaming disorder among the general population reported an overall prevalence rate of 3.3 %, which is notably lower than our findings [107]. This discrepancy may be due to the former analysis incorporating only a limited number of

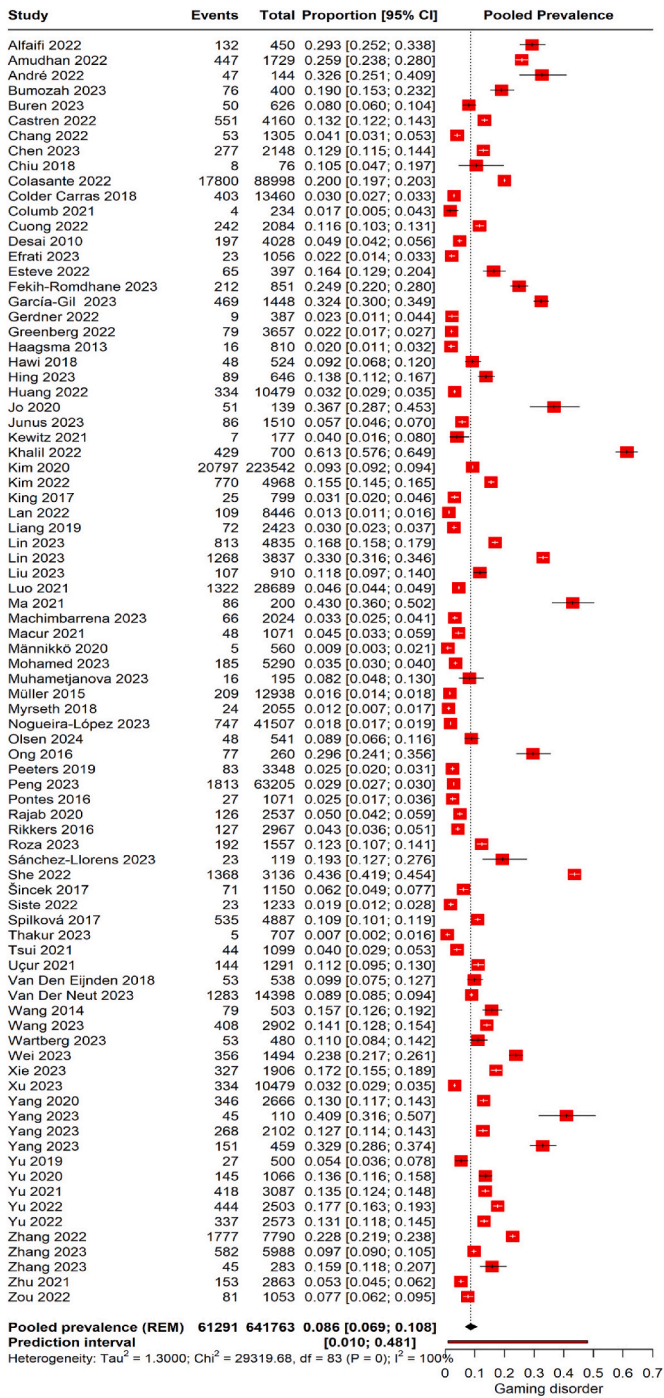


Fig. 2. Forest plot showing pooled prevalence of Gaming disorder among adolescents.

studies, whereas our research focused exclusively on adolescents and included a significantly larger and more recent collection of studies. This difference suggests that the prevalence of gaming disorder may have risen in recent years. Another meta-analysis that concentrated on video game addiction, encompassing 27 studies, determined a prevalence rate of 5 % [108]. This analysis also highlighted various factors influencing gaming disorders, including psychological, social, and personal aspects. The implications of these findings are far-reaching. With gaming disorder recognized by the WHO as a significant health concern, there is a clear need for the development of public health strategies to address the issue [8]. Prevention and intervention programs that focus on fostering healthy gaming habits and providing alternatives to gaming

Table 2
Prevalence of gaming disorder among various countries.

Country	Number of studies	Sample size	Prevalence (95 % CI)	Heterogeneity (I ²)
Saudi Arabia	3	3387	14.6 (1.9–60.0)	99 %
India	2	2436	4.8 (0.00–10.0)	99 %
Sweden	3	1072	9.5 (0.5–69.2)	98 %
Finland	2	4720	3.7 (0.00–10.0)	97 %
China	32	170526	11.7 (8.6–15.7)	100 %
Taiwan	2	8522	3.4 (0.00–99.8)	97 %
Ireland	1	234	1.7 (0.5–4.3)	NA
Vietnam	1	2084	11.6 (10.3–13.1)	NA
USA	2	7685	3.3 (0.1–60.5)	97 %
Israel	1	1056	2.2 (1.4–3.3)	NA
Spain	5	45495	9.6 (2.2–33.2)	100 %
Tunisia	1	851	24.9 (22.0–28.0)	NA
Netherlands	3	4696	3.7 (0.6–19.9)	97 %
Lebanon	1	524	9.2 (6.8–12.0)	NA
Australia	1	9380	7.2 (2.4–21.5)	99 %
Korea	2	223681	19.3 (0.00–99.8)	99 %
Germany	2	657	7.2 (0.1–92.2)	86 %
Egypt	1	700	61.3 (57.6–64.9)	NA
Iran	1	3837	33 (31.6–34.6)	NA
Slovenia	2	2142	3.4 (0.2–34.0)	83 %
Malaysia	1	5290	3.5 (3.0–4.0)	NA
Kyrgyzstan	1	195	8.2 (4.8–13)	NA
Norway	1	2055	1.2 (0.7–1.7)	NA
Brazil	1	1557	12.3 (10.7–14.1)	NA
Croatia	1	1150	6.2 (4.9–7.7)	NA
Indonesia	1	1233	1.9 (1.2–2.8)	NA
Turkey	1	1291	11.2 (9.5–13.0)	NA

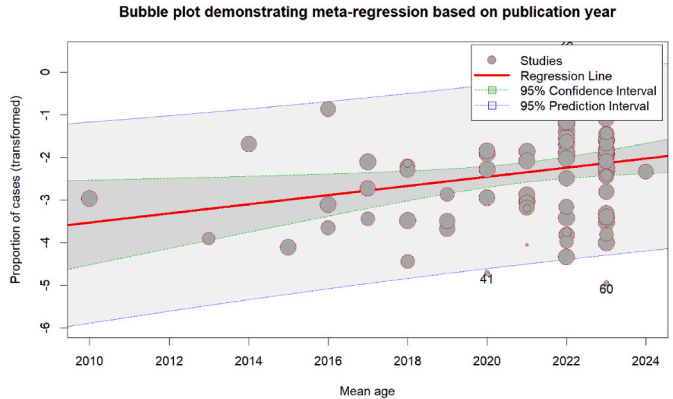


Fig. 3. Bubble plot showing the association of prevalence of gaming disorder and publication year.

could play a crucial role in mitigating the effects of gaming disorder [109]. Moreover, increased awareness and education about gaming disorder among parents, educators, and healthcare providers are essential to ensure early identification and support for affected individuals. The research also highlights several areas for future investigation. Longitudinal studies are needed to understand the long-term implications of gaming disorder on adolescent development and mental health. Furthermore, research exploring the efficacy of various intervention strategies could inform best practices for managing gaming disorder As digital technology continues to evolve, ongoing research into new forms of gaming and their potential impact on health is necessary. Virtual reality, augmented reality, and other emerging platforms present new challenges and opportunities for engagement with gaming that must be understood in the context of gaming disorder

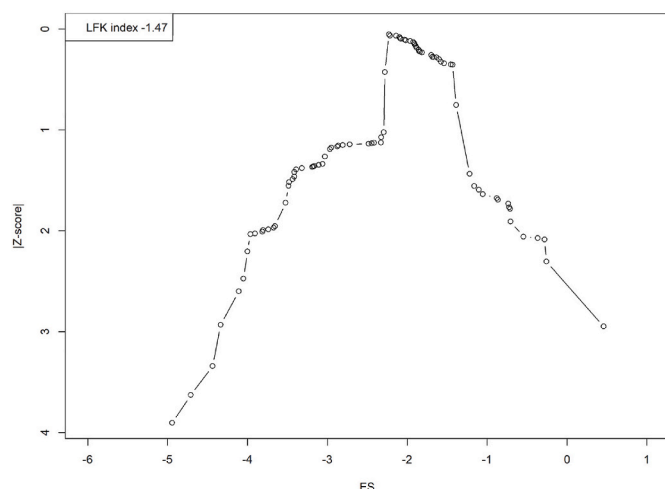


Fig. 4. Doi plot assessing publication bias.

[110].

Despite the comprehensive nature of this review and meta-analysis on the burden of gaming disorder among adolescents, several limitations must be acknowledged. The high degree of heterogeneity observed across included studies poses a significant challenge. The potential for publication bias, as indicated by the Doi plot, cannot be overlooked. Although Egger's test did not show statistical evidence of bias, the presence of asymmetry in the plot suggests that smaller studies with less favorable outcomes might be underrepresented. This could lead to an overestimation of the prevalence of gaming disorder among adolescents. The reliance on cross-sectional data for the majority of included studies limits the ability to infer causality between gaming and its adverse outcomes. Longitudinal studies are necessary to better understand the directionality of associations and the long-term impact of gaming disorder on adolescent development. The significant positive association found with the year of publication suggests an increasing trend in the prevalence of gaming disorder over time. However, this observation could also reflect the growing awareness and evolving definitions of gaming disorder, rather than an actual increase in its occurrence. As such, these findings should be interpreted with caution, acknowledging the evolving nature of gaming disorder diagnostics and the influence of digital technology trends on adolescent behaviours.

5. Conclusion

A significant prevalence of gaming disorder among adolescents has been revealed, indicative of a substantial public health concern. The increasing trend in the prevalence of gaming disorder, alongside the rapid evolution of digital technologies, necessitates ongoing monitoring and the development of targeted public health strategies to mitigate its effects. Fostering healthy gaming habits, enhancing awareness, and implementing effective intervention programs are essential steps toward addressing the global challenge of gaming disorder among adolescents.

Ethical approval

Not required.

Data availability

The data is with the authors and available on request.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests.

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Appendix A. Supplementary data

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