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Review

The emerging evidence on the association between symptoms of ADHD and gaming disorder: A systematic review and meta-analysis

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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

The co-existence of gaming disorder (GD) with other mental health problems has been widely reported. Despite the growing research interest in the comorbidity of GD with attention-deficit/hyperactivity disorder (ADHD), to date, no quantitative synthesis has been performed. The present study comprised a systematic literature search using *Scopus, Science Direct, Web of Science,* and *PubMed* databases. Three types of studies were included in the analyses: studies reporting (i) correlation coefficients between the symptoms of GD and ADHD, (ii) means, and standard deviations for comparison of GD severity between ADHD/non-ADHD individuals, and (iii) comparison of ADHD severity between GD/non-GD individuals. The results indicated a moderate relationship between GD and ADHD symptom severity when both subdomains of ADHD were combined ($r = 0.296$), and also when only inattention ($r = 0.306$) or hyperactivity ($r = 0.266$) symptoms were analyzed, which was also confirmed in a structural equation model meta-analysis. Studies showed a large average difference comparing the GD symptom severity of ADHD and non-ADHD individuals ($g = 0.693$), or ADHD symptom severity of GD and non-GD individuals ($g = 0.854$). In some cases, higher estimates of association were reported among studies that (i) had a higher proportion of males, (ii) assessed problematic internet use among predominantly videogame player samples rather than assessing only GD, and (iii) had been more recently published. The present review shows that this is an emerging field demonstrating significant results in cross-sectional correlational studies. However, future research should apply more rigorous methodologies to investigate the relationship further (e.g., longitudinal studies and studies using professional/clinical ratings and diagnosis). These results suggest that screening and treatment for ADHD among individuals with gaming disorder is necessary, and individuals with ADHD should be made aware of their higher susceptibility to gaming disorder.

1. Introduction

Attention-deficit/hyperactivity disorder (ADHD) is characterized by *"a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development"* (American Psychiatric Association, 2013, p. 59–66). Three types of diagnosis are used to cover the variation of symptom occurrence: (i) combined presentation (when both symptoms co-occur), (ii) predominantly inattentive presentation (when only the criterion for inattentive symptoms is fulfilled), and (iii) predominantly hyperactive/impulsive presentation (when only the criterion for hyperactive/impulsive symptoms is fulfilled). ADHD is primarily prevalent among the child/adolescent population, and the overall pooled prevalence in this age group has been reported to be 7.2% (Thomas, Sanders, Doust, Beller, & Glasziou, 2015). While symptoms usually disappear with aging, approximately 2.5% of the adult population still experiences them (Simon, Czobor, Bálint, Mészáros, & Bitter, 2009).

The higher prevalence of ADHD among those dependent on psychoactive substances is well-known. Approximately one-quarter of individuals with substance use disorder have comorbid ADHD (van

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Emmerik-van Oortmerssen et al., 2012), which poses an additional challenge in terms of treatment. This widely established comorbidity is not limited to substance use-related disorders. A higher co-occurrence of ADHD has also been reported among individuals with non-substance use-related addictive disorders such as gambling disorder, gaming disorder, and other problematic behaviors such as binge-eating, problematic internet use and compulsive sexual behaviors (Dullur, Krishnan, & Diaz, 2021; Karaca, Saleh, Canan, & Potenza, 2017; Savard et al., 2021).

Disorders due to addictive behavior (i.e., behavioral addictions) is a relatively new area with a strong research interest and a continuously growing number of studies (Billieux, Schimmenti, Khazaal, Maurage, & Heeren, 2015) due to the large number of individuals affected globally (e.g., Alimoradi, Lotfi, Lin, Griffiths, & Pakpour, 2022). Individuals suffering from behavioral addictions endure severe distress and functional impairment due to specific rewarding behaviors (e.g., playing videogames), similar to that which individuals with substance use disorders experience (Billieux et al., 2017). The clinical relevance of these conditions is also demonstrated by the World Health Organization's (WHO) decision to create a new category in the most recent version of the *International Classification of Diseases* (ICD-11) called 'Disorders due to addictive behaviours' and include gaming disorder, gambling disorder, as well as other specified and unspecified disorders due to addictive behaviors (WHO, 2019).

Possible negative consequences of excessive videogame playing have long been acknowledged both among researchers and in the clinical field. As a consequence, in 2013, internet gaming disorder (IGD) was included in the fifth edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-5) in Section III ('Emerging Measures and Models') as a non-substance-related disorder with a recommendation for further research (American Psychiatric Association, 2013). However, this led to an intense debate between scholars. The most important concerns regarding the inclusion were: (i) research underlying the decision was of low quality; (ii) the operationalization leaned too much on substance use and gambling criteria; (iii) there was a huge variation in symptomatology, (iv) the lack of consensus on the screening instruments to assess GD; and (v) making GD a formal diagnosis would cause stigma to the millions of children who play videogames in a healthy manner (Aarseth et al., 2017; Ko, Király, Demetrovics, Chang, & Yen, 2020).

Furthermore, some of the IGD criteria (e.g., preoccupation, tolerance, withdrawal) were also heavily criticized as not being suitable to differentiate individuals with GD from gaming enthusiasts (Griffiths et al., 2016; Király, Griffiths, & Demetrovics, 2015). After thoroughly discussing these concerns, the WHO decided that including GD in the ICD-11 as an official diagnosis had more advantages than disadvantages. Moreover, to address the critiques of specific criteria, the ICD-11 diagnosis only comprises those criteria, which have wide support, especially among professionals from the clinical field (Castro-Calvo et al., 2021). Nevertheless, the inclusion was highly criticized by the gaming industry and some researchers, the majority of whom were working in the field of media psychology and gaming studies (Ferguson & Colwell, 2020; Galanis, Delfabbro, & King, 2021).

According to the WHO, GD is a persistent and recurrent pattern of gaming behavior, characterized by loss of control over videogame use and neglect of other important areas of life (such as relationships, occupation and/or education), which persist despite the presence of several negative consequences that clinically impair day-to-day activities (WHO, 2019). A meta-analysis examining studies between 2009 and 2019 found that the worldwide prevalence of gaming disorder was 1.96% among samples with more strict sampling criteria (stratified random sampling) and occurring more frequently among male and adolescent populations (Stevens, Dorstyn, Delfabbro, & King, 2021). Numerous studies have reported associations between GD and other psychopathologies. The most frequently reported comorbidities are anxiety, depression, ADHD, social phobia, obsessive-compulsive symptoms (González-Bueso et al., 2018), and autism spectrum disorder (Murray et al., 2021).

A systematic review by Dullur et al. (2021) showed that the problematic use of videogames (and in more extreme cases, gaming disorder) is associated with ADHD. Recent findings not included in the review by Dullur et al. also reported an association between GD and ADHD (Cabelguen et al., 2021). This is also the case in longitudinal designs, where the association between preceding ADHD symptoms and subsequent GD severity has been shown to be mediated by a lower level of self-control and a higher level of aggression (Jeong et al., 2020).

1.1. Research aims

Considering the clinical relevance and frequent co-occurrence of ADHD and GD, the present study had three goals: (i) to test the association between the symptoms of the two disorders; (ii) to assess the quality of studies examining the comorbidity of the two disorders; and (iii) to estimate the effect of potential moderators in the association between the two disorders, such as age, gender, culture, methodological characteristics (assessment tool and informant), and overall study quality.

2. Methods

2.1. Systematic search

A systematic literature search was carried out using four different scientific databases: *Scopus, Science Direct, Web of Science* and *PubMed* with the following keywords: "ADHD" AND ("game" OR "gaming" OR "videogame") AND ("addiction" OR "problematic" OR "pathological" OR "disorder" OR "compulsive" OR "dependent" OR "excessive") NOT "gambling". Searches were carried out in three phases, and the final search was on June 2022, resulting in 839 hits in total. After the deletion of duplicates, 606 papers remained. All findings were exported to *EndNote* (6.0.1 version) software.

2.2. Eligibility screening, identification of additional studies

All of the titles and abstracts of the papers were scanned for eligibility by two doctoral students. Disagreements were resolved through discussion. Full texts were scanned to exclude studies (i) that did not assess gaming disorder/problematic internet use in relation to ADHD, but similar constructs (such as screen time), (ii) where problematic internet use was assessed, but the rate of videogame use was not reported or <50% of the study sample reported playing videogames, or (iii) that reported on data from the same database which was already identified in another paper in the present meta-analysis. A total of 95 full-text papers were screened for appropriate data for the meta-analysis. A total of 47 studies were excluded where necessary data were not reported in the paper, and the authors of those studies did not respond to the request through e-mail to provide the missing data. Study authors who were contacted were also asked to share any research related to the association between gaming disorder and ADHD symptoms that had not been published. However, no additional studies were identified through this request.

The present authors participated in two additional data collections in Hungary, which provided appropriate, but as yet unpublished data for the association in question. The first study was the Budapest Longitudinal Study (BLS), in which data were collected from a representative sample of fifth grade students. The other was a convenience sample of videogame players, which were used to the develop the Gaming Motivation Inventory, a comprehensive tool that assesses motives for videogame use (Király et al., 2022). Following this process, 48 studies remained for meta-analysis (see Fig. 1). This process was executed following PRISMA guidelines (Moher et al., 2009).

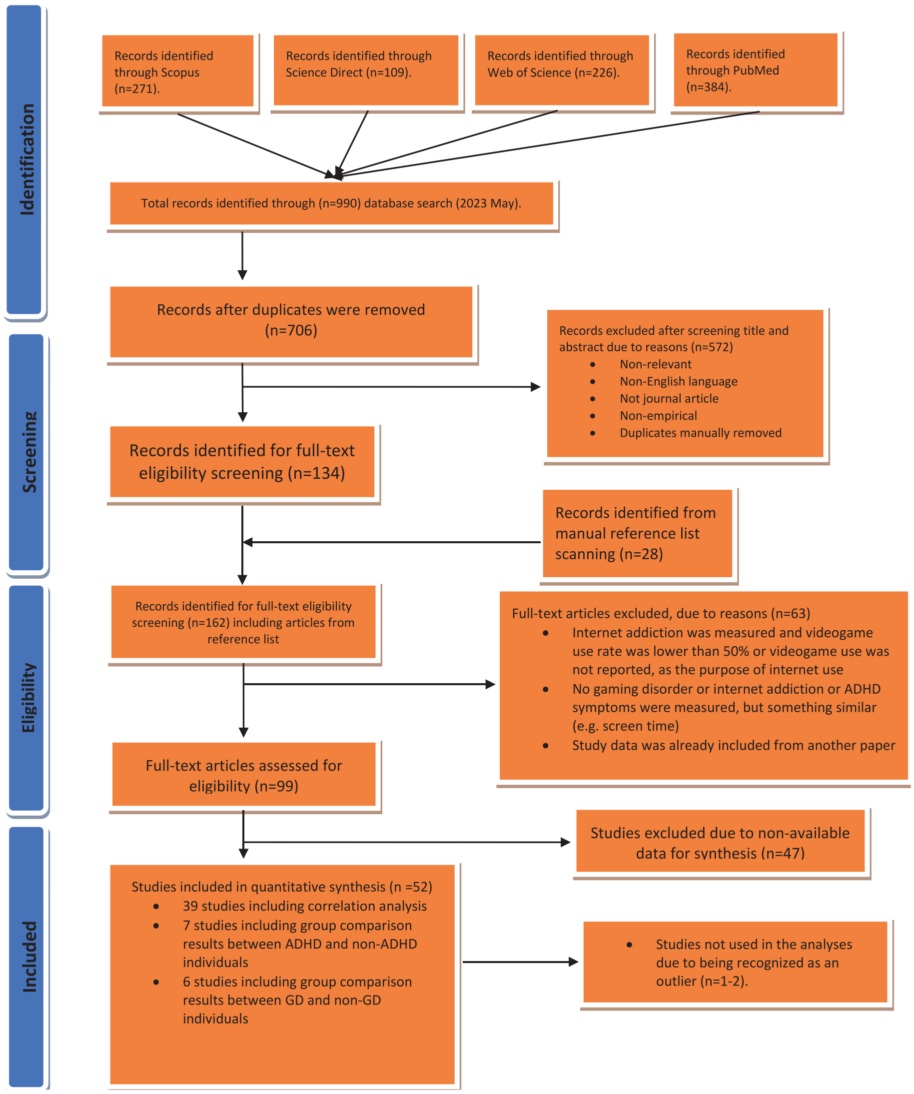


Fig. 1. Flowchart of the systematic database search and screening process.

2.3. Inclusion and exclusion criteria

The following eligibility criteria were used: empirical studies that reported results of a quantitative analysis concerning the association between GD and ADHD, either cross-sectionally or longitudinally, including a correlation coefficient or a group difference (e.g., ADHD/non-ADHD on symptoms of GD or GD/non-GD on symptoms of ADHD) reported), being published in the English language, and being published in a peer-reviewed journal. There was no restriction on publication date. Studies were excluded, where the purpose of internet use was not reported or lower than 50% of the sample reported gaming.

2.4. Coding process and type of data

Coders were undergraduate and graduate students. All coders were trained by the first author. Coding was done in pairs including a graduate and a PhD student, or two BA students under the supervision of the first author. In case of a disagreement between two coders, the first and the second authors were included to resolve the disagreement through discussion.

Three types of outcome data were identified in the primary studies: correlation coefficients (between two numerical variables of GD symptoms and ADHD symptoms); the means and standard deviations for symptoms of gaming disorder or problematic internet use in case of a comparison between a sample with and without ADHD; and the means and standard deviations for ADHD symptom severity in case of a comparison between participants with and without gaming disorder or problematic internet use. These were analyzed in three separate meta-analyses. In the first case, the correlation coefficients were coded as an effect size, while in the latter two analyses, Hedges' *g* was calculated for the standardized mean difference between the groups. In case of correlations, the type of correlation (Pearson or Spearman) was also coded in order to investigate whether they could be merged in the same analysis. Data related to ADHD symptom severity were coded for the two subdomains of ADHD separately (inattention and hyperactivity/impulsivity) if the data were available.

In case of longitudinal studies, cross-sectional data from the first data collection phase was coded with one exception. The one exception was the study by Marmet, Studer, Grazioli, and Gmel (2018), where the use of the data from the third wave was recommended by the authors, because at that time point no modifications were applied to the assessment tool (i.e., Gaming Addiction Scale), and probably resulting in more reliable estimates.

The following moderator variables were coded: sample type (clinical/non-clinical), mean age of the sample, gender distribution in the sample, country data were collected in, year of data collection, ADHD assessment tool and the informant (self-report/parent report/teacher report/professional rating), GD/IA assessment tool and the informant (self-report/parent report/teacher report/professional rating), and the type of addiction (only gaming-related problems or problems partly related to gaming and partly to any other internet-based activities). Samples were categorized as clinical, when the participants were recruited from mental healthcare institutions and where they received official diagnosis, while samples were categorized as non-clinical when they were recruited from other places than mental healthcare institutions (e.g., schools, gaming-related sites and forums). For the year of data collection, if it was not reported in the paper, the value was imputed by the publication year −2 formula (for a similar procedure, see Protzko, 2020). Where data were collected over two years, the mean of the publication years was coded. To unify the different scale names used in the studies, five review studies were used (i.e., Collett, Ohan, & Myers, 2003; King et al., 2020; King, Haagsma, Delfabbro, Gradisar, & Griffiths, 2013; Laconi, Rodgers, & Chabrol, 2014; Taylor, Deb, & Unwin, 2011). Inter-rater reliability was calculated separately for effect size data (sample sizes, correlation coefficients, means, and standard deviations) and for moderators (mean age, gender distribution, year of data collection, etc.). The inter-rater reliability percentages were acceptable for both the outcome measures (97%) and the moderators (95%).

2.5. Contact with the study authors

Study authors were contacted through e-mail to collect information not reported in their studies, such as data to calculate an effect size and values for moderator variables. Additionally, authors with multiple papers were asked questions regarding possible overlap of the samples in these studies. Non-independent samples were removed from the final database in order to make sure that participants were only included once in the analyses.

2.6. Quality assessment

For the assessment of the methodological quality of the studies included in the present meta-analysis, the protocol of Murray et al. (2021) was followed, and studies were rated on five criteria: (i) the relevancy and importance of research question; (ii) the evidence and appropriateness of study design; (iii) the possibility of sampling bias; (iv) how well-defined and robust the ADHD assessment was; and (v) how well-defined and robust GD assessment was. All criteria were rated on a 0–2 scale by graduate students in pairs. If any disagreement occurred, it was resolved by discussion with the inclusion of one of the authors. Overall study quality score ranged between 0 and 10. Studies were rated as (i) high quality with a score of 8 or more; (ii) medium quality with a score of 3 to 7.5; and low quality with a score below 3.

2.7. Statistical analysis

Data were analyzed using the *Comprehensive Meta-Analysis Version 3.0* software (Borenstein, Hedges, Higgins, & Rothstein, 2009). The random-effects model was used in all analyses. For correlational data, results were inspected using both the correlation coefficient and Fisher's z-values as the effect size. Results were very similar regarding these two values, so results of correlation coefficients are reported. For data regarding group differences, the means, and standard deviations were used to calculate the standardized mean difference Hedges' *g* as the effect size. Additional studies not suitable for data synthesis (because of the low number of such studies with adequate heterogeneity in the reported statistical indicators) were included, with their results being reported qualitatively. These studies utilized ratings provided by professionals (clinicians) for the diagnosis of both disorders reporting the rates of having an ADHD diagnosis in groups with and without GD. Furthermore, a qualitative description of the longitudinal studies was also carried out.

Outliers exceeding a standardized residual of ±3.29 were removed from the analyses. The software weights the studies according to the inverse of the standard error so that studies with larger samples have more weight in the average effect. The possibility of publication bias was tested in all analyses using the funnel plot method (Egger, Smith, Schneider, & Minder, 1997). In case asymmetry was identified, Duval and Tweedie's (2000) trim and fill method was utilized to adjust the average effect size. Additionally, Rosenthal's fail-safe N method (Rosenthal, 1979) was used to calculate the number of studies required to turn the results non-significant. As a rule of thumb, an estimate exceeding 5 k + 10 can be interpreted as reflecting a robust average effect. Heterogeneity of the average effects was assessed using the Q-statistic and I^2 (Borenstein et al., 2009).

In cases of notable heterogeneity, meta-regressions were run to test the effect of the sample's mean age, gender distribution, and the year of data collection. Subgroup analyses were carried out if more than two studies reported sufficient data to perform subgroup analysis between at least two subgroups for the following variables: sample type, country of data collection, ADHD assessment tool and informant (for ADHD), GD/IA assessment tool and informant (for GD/IA). For the interpretation of Cohen's *d* and Pearson Product Moment *r* values, the guidelines of Cohen (1988) were used.

The correlations between GD and the two subdomains of ADHD were also explored using a structural equation model (SEM) meta-analysis (Cheung & Chan, 2009). This approach allowed for the simultaneous analysis of GD and both ADHD subdomains within a single model, considering their correlation. By combining the outcomes in this way, the analysis benefits from increased statistical power, enabling more precise estimates and potentially more reliable results (Harrer, Cuijpers, Furukawa, & Ebert, 2021).

3. Results

3.1. Descriptive statistics

From the 39 studies reporting correlational data, 43 independent samples were identified (Table 1). More specifically, 32 effect sizes were found for the correlation between GD and inattention symptoms and 31 effect sizes were found for the correlation between GD and hyperactivity/inattention symptoms. Seven studies comprising seven effect sizes reported on group comparisons between ADHD and non-ADHD individuals regarding GD symptom severity (Table 2). Finally, six studies reporting seven effect sizes were found comparing groups of GD and non-GD responders regarding ADHD symptom severity (Table 3).

3.2. Preliminary subgroup analysis for studies with parametric and non-parametric correlation

A preliminary analysis tested whether the effect sizes based on non-parametric correlation analyses (i.e., Spearman's correlation coefficients) had a different average effect size compared to the effect sizes using parametric correlation results (i.e., Pearson's correlation coefficients) using mixed effect model estimates for the association between GD and combined ADHD, inattention, and hyperactivity/impulsivity scores. The average effect size was similar in studies reporting non-parametric correlation statistics ($r = 0.308$, $k = 6$, SE = 0.0334, 95% CI = [0.241; 0.372], $p < .001$) compared to parametric statistics ($r = 0.294$, $k = 35$, SE = 0.0171, 95% CI = [0.260; 0.327], $p < .001$)(Q = 0.140, df = 1, $p = .708$) with combined ADHD scores.

Secondly, for the analysis including inattention scores, no differences were found between the average effect sizes of studies reporting non-parametric correlation statistics ($r = 0.331$, $k = 4$, SE = 0.0569, 95% CI = [0.215; 0.438], $p < .001$) compared to parametric statistics ($r = 0.302$, $k = 27$, SE = 0.0219, 95% CI = [0.258; 0.344], $p < .001$)(Q = 0.222, df = 1, $p = .637$). Similarly, the subgroup analysis did not

Table 1
Characteristics of studies included in the meta-analysis (studies with correlation data of the association between gaming disorder symptom severity and combined ADHD scores).

Characteristics of studies included in the meta-analysis (studies including results of correlation analyses) Study	Sample type	Sample size	Mean age	Gender distribution (male %)	Country (of sample)	Date of data collection	ADHD measurement	Source of data (ADHD)	GD/IA measurement	Source of data (GD/IA)
Andreassen et al. (2016)	Non-clinical	23,533	35.8	35	Norway	2014	Adult Self Report Scale-18	Self-report	Game Addiction Scale-7	Self-report
Bielefeld et al. (2017)	Clinical	29	34.08	66	Germany	N.R.	Conners' Adult ADHD Rating Scale	Self-report	Internetsuchtskala	Self-report
BLS study, unpublished	Non-clinical	1400	10.71	48.9	Hungary	2018	Strengths and Difficulties Questionnaire	Self-report	Internet Gaming Disorder Test-10	Self-report
Chen et al. (2021)	Non-clinical	1236	20.39	39.8	China	2018	Adult Self Report Scale-6	Self-report	Internet Gaming Disorder Scale-9	Self-report
Concerto et al. (2021)	Non-clinical	4260	N.R.	84.13	Italy	2020.5	Adult Self Report Scale-18	Self-report	Internet Gaming Disorder Scale-9	Self-report
Demirtaş et al. (2021)	Clinical	95	14.35	75.8	Turkey	2018	Conners' Parent Rating Scale-48	Parent-report	Internet Addiction Test	Self-report
Evren, B. et al. (2017)	Non-clinical	1010	21.85	40	Turkey	2017.5	Adult Self Report Scale-6	Self-report	Internet Addiction Test-12	Self-report
Evren, C. et al. (2019)	Non-clinical	987	23.65	57.44	Turkey	2018	Adult Self Report Scale-6	Self-report	Internet Gaming Disorder Scale-9	Self-report
Ferguson & Ceranoglu (2014)	Non-clinical	144	12.7	52.8	USA	2012.5	Child Behavior Checklist (CBCL)	Parent-report	7-item scale of pathological gaming	Self-report
Jung et al. (2020)	Non-clinical	51	23.1	100	South Korea	N.R.	Conners' Adult ADHD Rating Scale	Self-report	Internet Game Addiction Questionnaire	Self-report
Kahraman & Demirci (2018)	Clinical	111	13.9	N.R.	Turkey	2014.5	Atilla Turgay DSM-IV-Based Child and Adolescent Disruptive Behavioral Disorders Screening and rating Scale	Parent-report	Young Internet Addiction Scale	Self-report
Kandeğer & Egilmez (2022)	Non-clinical	376	21.83	100	Turkey	2020	Adult Self Report Scale-6	Self-report	Internet Gaming Disorder Scale-9	Self-report
Kawabe et al. (2019)	Clinical	55	13.4	76.36	Japan	2017.5	ADHD Rating Scale-IV	Parent-report	Internet Addiction Test	Self-report
Kietglaiwansiri & Chonchaiya (2018)	Non-clinical	102	10.09	50	Thailand	2015	Swanson, Nolan, and Pelham-IV Questionnaire	Teacher-report	Game Addiction Screening Test	Parent-report
Kim et al. (2020)	Clinical	94	20.25	100	South Korea	N.R.	ADHD Rating Scale-IV	Parent-report	Young Internet Addiction Scale	Self-report
Lee et al. (2018)	Non-clinical	2801	22.43	93	Mixed (USA, Canada, Sweden, Germany, others unknown)	2013.5	Conners' Adult ADHD Rating Scale	Self-report	Internet Addiction Test	Self-report
Lefler et al. (2023)	Non-clinical	1489	19.13	30.06	USA	N.R.	DSM-V criteria	Self-report	11-item Pathological-Gaming Scale based on the DSM–IV gambling criteria	Self-report
Li et al. (2016)	Non-clinical	73	22.56	53.4	China	N.R.	Adult Self Report Scale-18	Self-report	Chen Internet Addiction Scale	Self-report
Marmet et al. (2018)	Non-clinical	5501	25.44	100	Switzerland	2017	Adult Self Report Scale-6	Self-report	Game Addiction Scale-7	Self-report
Masi et al. (2021)	Clinical	280	7.68	65.4	Canada	2017	Questionnaire on Attention and Computers	Parent-report	Questionnaire on attention and computers	Parent-report
Masklavanou et al. (2022)	Non-clinical	515	26.8	86.35	Greece	2022	ADHD Rating Scale-IV	Self-report	Internet Gaming Disorder Scale-9	Self-report

(continued on next page)

Table 1 (*continued*)

Characteristics of studies included in the meta-analysis (studies including results of correlation analyses) Study	Sample type	Sample size	Mean age	Gender distribution (male %)	Country (of sample)	Date of data collection	ADHD measurement	Source of data (ADHD)	GD/IA measurement	Source of data (GD/IA)
Mazurek & Engelhardt (2013)	Clinical	44	11.7	100	USA	2011	Vanderbilt ADHD Rating Scale	Parent-report	Problem Videogame Playing Scale	Parent-report
Mazurek & Engelhardt (2013)	Clinical	56	11.1	100	USA	2011	Vanderbilt ADHD Rating Scale	Parent-report	Problem Videogame Playing Scale	Parent-report
Mazurek & Engelhardt (2013)	Non-clinical	41	12.2	100	USA	2011	Vanderbilt ADHD Rating Scale	Parent-report	Problem Videogame Playing Scale	Parent-report
Menendez-García et al. (2022)	Clinical	112	N.R.	36.61	Spain	N.R.	ATENTO	Parent-report	ADITEC	Parent-report
Panagiotidi (2017)	Non-clinical	205	27.4	48.78	UK	N.R.	Adult Self Report Scale-18	Self-report	Problem Videogame Playing Scale	Self-report
Peeters et al. (2018)	Non-clinical	544	13.9	48.9	Netherlands	2015.5	ADHD-Vragenlijst (AVL)	Self-report	Internet Gaming Disorder Scale-9	Self-report
Schoenmacker et al. (2020)	Clinical	362	15.93	80.66	Mixed (Germany, Netherlands, Belgium)	2004.5	Parental Account of Childhood Symptoms	Parent-report	Game Addiction Scale-21-modified	Self-report
Stavropoulos et al. (2019)	Non-clinical	163	23.01	75.4	Australia	2016.5	Adult Self Report Scale-18	Self-report	Internet Gaming Disorder Scale-9	Self-report
Stavropoulos et al. (2019)	Non-clinical	398	25.25	58.11	USA	2016	Adult Self Report Scale-18	Self-report	Internet Gaming Disorder Scale-9	Self-report
Stavropoulos et al. (2020)	Non-clinical	1031	25.74	48.7	Mixed (Australia, United States of America, United Kingdom, Canada, New Zealand)	2018.5	Adult Self Report Scale-18	Self-report	Internet Gaming Disorder Scale-9	Self-report
Taner et al. (2022)	Non-clinical	290	20	38.27	Turkey	2019.5	Adult Self Report Scale-18	Self-report	Computer Gaming Addiction Scale	Self-report
Király et al. (2022)	Non-clinical	12,842	24.1	89.3	Hungary	2020	Adult Self Report Scale-6	Self-report	Internet Gaming Disorder Test-10	Self-report
Tolchinsky & Jefferson (2011)	Non-clinical	216	N.R.	43.98	USA	N.R.	Assessment of Hyperactivity and Attention (AHA)	Self-report	Problem Videogame Playing Scale	Self-report
Tzang et al. (2022)	Clinical	102	11.27	68.6	Taiwan	2020	Swanson, Nolan, and Pelham-IV Questionnaire	Parent-report/ Teacher report	Chen Internet Addiction Scale	Self-report
Vadlin et al. (2016)	Clinical	242	15.39	30.2	Sweden	2014.5	Adult Self Report Scale-18	Self-report	Gaming Addiction Identification Test	Self-report
Vadlin et al. (2016)	Non-clinical	1868	13.9	44.6	Sweden	2012	Adult Self Report Scale-18	Self-report	Gaming Addiction Identification Test	Self-report
Vally (2021)	Non-clinical	214	20.64	44.9	United Arab Emirates	2019.5	Adult Self Report Scale-18	Self-report	Internet Gaming Disorder Scale-9	Self-report
Walther et al. (2012)	Non-clinical	2553	16.7	50.7	Germany	2010	Rating Scale for Attention-Deficit/ Hyperactivity Disorder	Self-report	Video Game Dependency Scale	Self-report
Wartberg et al. (2019)	Non-clinical	1095	12.99	50.8	Germany	2016	Strengths and Difficulties Questionnaire	Parent-report	Internet Gaming Disorder Scale-9	Self-report
Wichstrøm et al. (2019)	Non-clinical	702	10.5	48.6	Norway	2014	Child and Adolescent Psychiatric Assessment	Professional-rating	Internet Gaming Disorder Interview	Professional-rating
Yılmaz et al. (2015)	Non-clinical	640	16.0	48.3	Turkey	N.R.	Conners-Wells' Adolescent Self-Report Scale-27	Self-report	Internet Addiction Scale	Self-report
Yoo et al. (2004)	Non-clinical	535	11.0	49.4	South Korea	N.R.	ADHD Rating Scale-IV	Parent-report, Teacher-report	Internet Addiction Test	Self-report

N.R. = not reported.

indicate any differences between the average effect sizes of studies reporting non-parametric correlation statistics ($r = 0.297$, $k = 4$, SE = 0.0538, 95% CI = [0.188; 0.399], $p < .001$) compared to parametric statistics ($r = 0.260$, $k = 25$, SE = 0.0217, 95% CI = [0.217; 0.302], $p < .001$) (Q = 0.408, df = 1, $p = .523$) including hyperactivity/impulsivity scores. Given the analysis found no indication that different correlation coefficients overestimated or underestimated the association, no studies were excluded from the analysis where Spearman's correlation was used.

3.3. Meta-analysis of studies reporting on correlational analyses

A medium-sized, significant positive association was found between combined ADHD scores and gaming disorder symptom severity: $r = 0.296$, $k = 41$, SE = 0.0153, 95% CI = [0.266, 0.326], $p < .001$ (Fig. 2). More specifically, gaming disorder symptom severity also showed moderate-sized significant average correlations with both ADHD inattention scores ($r = 0.306$, $k = 31$, SE = 0.0202, 95% CI = [0.266, 0.345], $p < .001$) (Fig. 3) and ADHD hyperactivity/impulsivity scores ($r = 0.266$, $k = 29$, SE = 0.0202, 95% CI = [0.226, 0.305], $p < .001$) (Fig. 4). In all three average effects, there was significant heterogeneity between the studies (Q = 481.003, df = 40, $p < .001$, $I^2 = 92\%$ for the effect sizes with combined ADHD scores; Q = 306.437, df = 30, $p < .001$, $I^2 = 90\%$ for the effect sizes with ADHD inattention scores; Q = 258.426, df = 28, $p < .001$, $I^2 = 89\%$ for the effect sizes with ADHD hyperactivity/impulsivity scores).

According to the classic fail-safe N method these average effects were robust (i.e., 31,960 non-significant studies would be needed to turn the average effect non-significant in case of combined ADHD symptom severity scores, 13,912 studies in case of ADHD inattention symptom severity scores, and 8016 studies in case of ADHD hyperactivity/impulsivity severity scores). Funnel plots including the combined and the subdomain scores of ADHD showed some slight asymmetry. Duval and Tweedie's trim and fill method indicated one trimmed study for studies with combined ADHD scores, where the adjusted average effect remained significant ($r = 0.294$, 95% CI = [0.264; 0.324], $p < .001$) (Fig. 5). Regarding ADHD inattention scores, three trimmed studies were identified, where the average effect size, again, remained significant ($r = 0.291$, 95% CI = [0.251; 0.330], $p < .001$) (Fig. 6). Finally, in the case of ADHD hyperactivity/impulsivity scores, six trimmed studies were calculated, resulting in a significant adjusted average effect size ($r = 0.2223$, 95% CI = [0.180; 0.265], $p < .001$) (Fig. 7).

As a result of the subgroup analysis comparing the effect sizes between the two types of disorders assessed, significantly larger correlation coefficient estimates between GD symptom scores and ADHD inattention subdomain scores were found for studies assessing problematic internet use in predominantly videogame player samples compared to studies where only gaming disorder severity was assessed (Fig. 8). Furthermore, gender ratio positively predicted the correlation coefficient between gaming disorder severity and combined ADHD scores (Fig. 9), suggesting that the association is larger for males, but the effect estimate was negligible Neither the remaining subgroup analyses (clinical versus non-clinical samples, country of data collection (Germany, Turkey, USA), GD assessment tools (Internet Addiction Test, Internet Gaming Disorder Scale Short-Form, Problem Videogame Playing Scale) and source (self-report versus parent-report), ADHD assessment tools (ADHD Rating Scale-IV, Adult Self Report Scale 6-item screener version, Adult Self Report Scale 18-item version) and source (self-report or parent-report), nor the other meta-regressions (mean age of the sample, year of data collection, overall study quality) performed on the average correlation coefficients including any ADHD data type (combined, inattention, hyperactivity/impulsivity) resulted in significant results regarding potential moderators (Tables 4-7). Average effect sizes in all categories in the subgroup analyses showed moderately-sized significant positive correlations between GD and ADHD symptoms, irrespective of the characteristics of the sample or the assessment tool used (Table 4-6).

3.4. SEM meta-analysis

In the first step of the analysis, we examined the data from thirteen studies that provided information on the correlation between Hyperactivity/Impulsivity and Inattention. Combining the data, we found that the weighted mean correlation between these two outcomes was $r = 0.35$. Subsequently, we calculated the study-level covariances of the two outcomes that we used to fit the model (Cheung & Chan, 2009).

We found that the univariate effect sizes for the relation between symptoms of ADHD and GD were both significantly larger than zero. For Hyperactivity/Impulsivity, the correlation was $r = 0.28$ (95%CI [0.22, 0.34] z = 8.37, $p < .001$). Similarly, for Inattention, the correlation was $r = 0.33$ (95%CI [0.27, 0.38] z = 10.91, $p < .001$). Both effects displayed substantial heterogeneity, exceeding 95%. Moreover, we found a strong positive association between the two effects ($r = 0.90$). In other words, individuals who exhibited higher levels of GD were likely to experience both Hyperactivity/Impulsivity and Inattention symptoms of ADHD concurrently (See Fig. 10).

3.5. Meta-analysis on studies including group comparison results

In studies where individuals with and without an ADHD diagnosis were compared, a moderate-to-large positive difference was found regarding GD symptom severity: $g = 0.693$, $k = 7$, SE = 0.129, 95% CI = [0.440, 0.945], $p < .001$ (Fig. 11). Similarly, studies comparing individuals with and without gaming disorder also showed a significant, large difference: $g = 0.854$, $k = 7$, SE = 0.226, 95% CI = [0.411, 1.296], $p < .001$ (Fig. 12). The analyses indicated significant heterogeneity among the studies (Q = 37.010, df = 6, $p < .001$, $I^2 = 84\%$ for GD symptom severity in ADHD/non-ADHD comparison; Q = 60.921, df = 6, $p < .001$, $I^2 = 90\%$ for ADHD symptom severity in GD/non-GD comparison).

The classic fail-safe N method indicated that 321 non-significant results would be necessary to turn the average difference between the ADHD and non-ADHD groups non-significant and 261 for the group comparison between GD and non-GD groups. These results suggest robust effects. The funnel plots showed symmetrical distributions. Duval and Tweedie's trim and fill method did not indicate any trimmed studies for either the ADHD/non-ADHD, or for the GD/non-GD comparison. Therefore, no evidence of publication bias was found and the average effects were robust.

Although the number of available studies was quite low, moderator analyses were carried out where appropriate. Only one continuous moderator showed a significant effect in these group comparison meta-analyses. The year of data collection (ranging from 2007 to 2019) positively predicted the size of the difference in gaming disorder symptom severity between ADHD and non-ADHD individuals in the available seven studies (i.e., more recent studies tended to find a larger difference; Fig. 13). This was a small association showing 0.05 point of increase in symptom severity of GD with every year. All other meta-regressions showed non-significant results (Table 8).

Subgroup analyses could only be performed for the type of addiction assessed for the group mean difference estimates of combined ADHD symptom severity between GD and non-GD groups. When pooling effect sizes in studies measuring gaming disorder showed a significant, large difference ($g = 0.798$, $k = 4$, SE = 0.156, 95% CI = [0.493, 1.105], $p < .001$), while studies assessing problematic internet use in predominantly videogame player samples showed a large average difference that failed

Table 2
Characteristics of studies included in the meta-analysis (group comparison studies between GD and non-GD individuals).

Study	GD/IA group		Non-GD/IA group		Mean age	Gender distribution (male %)	Country (of sample)	Date of data collection	ADHD measurement	Source of data (ADHD)	GD/IA measurement	Source of data (GD/IA)
	Sample type	Sample size	Sample type	Sample size								
Berloffa et al. (2022)	Clinical	48	Clinical	60	11.7	88.88	Italy	2020.5	Conners' Parent Rating Scale-27	Parent-report	Internet Gaming Disorder Scale-9	Self-report
Cao & Su (2007)	Non-clinical	64	Non-clinical	64	14.7	82.81	China	N.R.	Strengths and Difficulties Questionnaire	Parent-report	Young Internet Addiction Scale	Self-report
Melek & Eroğlu (2019)	Clinical	100	Non-clinical	95	N.R.	57.7	Turkey	N.R.	DSM-V criteria	Professional-rating	Internet Addiction Test	Self-report
Pearcy et al. (2017)	Non-clinical	34	Non-clinical	370	23.8	70.01	Mixed (Australia, USA, etc.)	2015	Adult Self Report Scale-18	Self-report	Personal Internet Gaming Disorder Evaluation-9	Self-report
Seong et al. (2019)	Clinical	152	Non-clinical	138	26.06	89.7	South Korea	2018	ADHD Rating Scale-IV	Self-report	Internet Addiction Test	Self-report
Starcevic et al. (2020)	Cinical	36	Clinical	64	21.2	94	South Korea	N.R.	Adult Self Report Scale-18	Self-report	Gaming Diagnostic Interview	Professional-rating

N.R. = not reported.

to reach significance ($g = 0.879$, $k = 3$, SE = 0.457, 95% CI = [−0.017, 1.775], $p = .054$)(Q = 0.028, df = 1, $p = .868$).

Subgroup analyses were performed for studies where ADHD and non-ADHD individuals were compared for the person of informant and the sample type of the ADHD group (clinical or non-clinical). Professional ratings showed a significant, moderate-sized effect ($g = 0.623$, $k = 3$, SE = 0.173, 95% CI = [0.285, 0.962], $p < .001$), while pooling self-reported ratings resulted in a large average difference ($g = 0.877$, $k = 3$, SE = 0.173, 95% CI = [0.539, 1.216], $p < .001$) of gaming disorder symptoms severity when ADHD and non-ADHD individuals were compared. (Q = 1.081, df = 1, $p = .299$). A similar result was found when attempting to compare the effects found in clinical and non-clinical samples. Studies including clinical samples showed a large average difference ($g = 0.795$, $k = 4$, SE = 0.132, 95% CI = [0.537, 1.053], $p < .001$), while studies applying non-clinical samples showed a moderate-sized difference ($g = 0.630$, $k = 3$, SE = 0.211, 95% CI = [0.530, 0.968], $p = .003$)(Q = 0.446, df = 1, $p = .504$).

In summary, medium-to-large significant, positive differences were found in all subgroup analyses of ADHD/non-ADHD and GD/non-GD group comparison with one exception: no significant difference was found in studies where GD and non-GD groups were compared using measurement for problematic internet use among predominantly videogame player samples.

3.6. Studies with professional/clinical diagnoses of both ADHD and GD

Two small-scale studies found substantially different rates of ADHD among patients with GD: 12.5% (Van Rooij, Schoenmakers, & Van de Mheen, 2017) and 83.3% (Bozkurt, Coskun, Ayaydin, Adak, & Zoroglu, 2013), while a large-scale study including 755 patients with GD reported the rate of co-existent ADHD in 32.7% of the cases (Han, Yoo, Renshaw, & Petry, 2018). One case-control study reported rates of ADHD diagnosis among patients with GD and an age, gender, and education level-matched control group, indicating that it was 13 times more likely to have a diagnosis of ADHD among individuals with GD compared to those without GD (Yen et al., 2017).

3.7. Findings of longitudinal studies

Six studies reported data regarding longitudinal links between ADHD and GD. The question of a possible longitudinal association between the symptoms of the two disorders was first explored by Ferguson and Ceranoglu (2014). In their study, pre-existing attention problems predicted problematic gaming later after controlling for gender ($\beta = 0.19$), but the opposite direction was non-significant. Peeters and colleagues (2018) only tested the effect of earlier inattentive symptoms on later GD symptoms, which was found to be significant after controlling for gender. The association between the symptoms of the two disorders was stronger for socially vulnerable individuals with low life-satisfaction. Wartberg and colleagues (2019) tested both directions of predictive effect and similar to previous research findings, only previously present ADHD symptoms predicted subsequent GD symptoms ($\beta = 0.14$).

In contrast, both directions were significant in a large-scale study by Marmet et al. (2018), indicating a bidirectional association between the symptoms of the two disorders (probit = 0.066 for the prediction of GD symptoms from earlier ADHD symptoms; probit = 0.058 for the prediction of ADHD symptoms from earlier GD symptoms). In further analysis, the same association was tested, including the two subdomains of ADHD in the same model. The findings indicated a reciprocal association only in case of inattentive symptoms (probit = 0.090 for the prediction of GD symptoms from earlier inattention symptoms; probit = 0.044 for the prediction of inattention symptoms from earlier GD symptoms), but not hyperactivity/impulsivity. One additional study with only ADHD affected individuals indicated that inattentive symptoms, but not hyperactivity symptoms predicted GD symptom severity (Schoenmacker et al., 2020). In contrast to the previous findings, the

Table 3
Characteristics of studies included in the meta-analysis (group comparison studies between ADHD and non-ADHD individuals).

Study	ADHD group		Non-ADHD group		Mean age	Gender distribution (male %)	Country (of sample)	Date of data collection	ADHD measurement	Source of data (ADHD)	GD/IA measurement	Source of data (GD/IA)
	Sample type	Sample size	Sample type	Sample size								
Başgül et al. (2020)	Clinical	100	Non-clinical	100	11.68	71	Turkey	N.R.	Medical record	Professional-rating	Computer Game Addiction Scale for Children	N.R.
Evren, C. et al. (2021)	Non-clinical	143	Non-clinical	602	23.06	68.9	Turkey	2019	Adult Self Report Scale-6	Self-report	Internet Gaming Disorder Scale-9	Self-report
Gentile (2009)	Non-clinical	144	Non-clinical	984	13.2	49.92	USA	2007	Medical record	Professional-rating	11-item Pathological-Gaming Scale based on the DSM–IV gambling criteria	Self-report
Kwak et al. (2020)	Clinical	14	Non-clinical	12	N.R.	N.R.	South Korea	2017	ADHD Rating Scale-IV	Self-report	Young Internet Addiction Scale	Self-report
Paulus et al. (2018)	non-clinical	91	Non-clinical	1176	5.8	49.9	Germany	2011.5	Diagnostik-System für psychische Störungen nach ICD-10 und DSM-IV für Kinder und Jugendliche-II	Parent-report	Young Children-Computer Gaming Disorder questionnaire	Parent-report
Razjouyan et al. (2020)	Clinical	99	Non-clinical	99	N.R.	67	Iran	N.R.	Conners' ADHD Rating Scale	Self-report	Internet Addiction Test	Self-report
Weinstein et al. (2015)	Clinical	50	Non-clinical	50	13.88	100	Israel	2015	Medical record	Professional-rating	Internet Addiction Test	Self-report

N.R. = not reported.

prospective association between earlier ADHD symptoms and later GD symptoms was not significant in the study by Wichstrøm and colleagues (2019).

3.8. Quality assessment

Based on the quality assessment, no low-quality studies were identified, and most of the studies (38 out of 52) were rated as high-quality in general (Table 9-11). Among studies reporting correlation analysis, only the possibility of sampling/selection bias was identified as a common problem (Table 9). In studies including group comparisons between ADHD and non-ADHD individuals, sampling/selection bias and the use of less reliable GD/IA assessment tools were identified, affecting general study quality (Table 10). Ratings of studies including a comparison between GD and non-GD samples were all rated high in all aspects, with no systematic quality issue (Table 11).

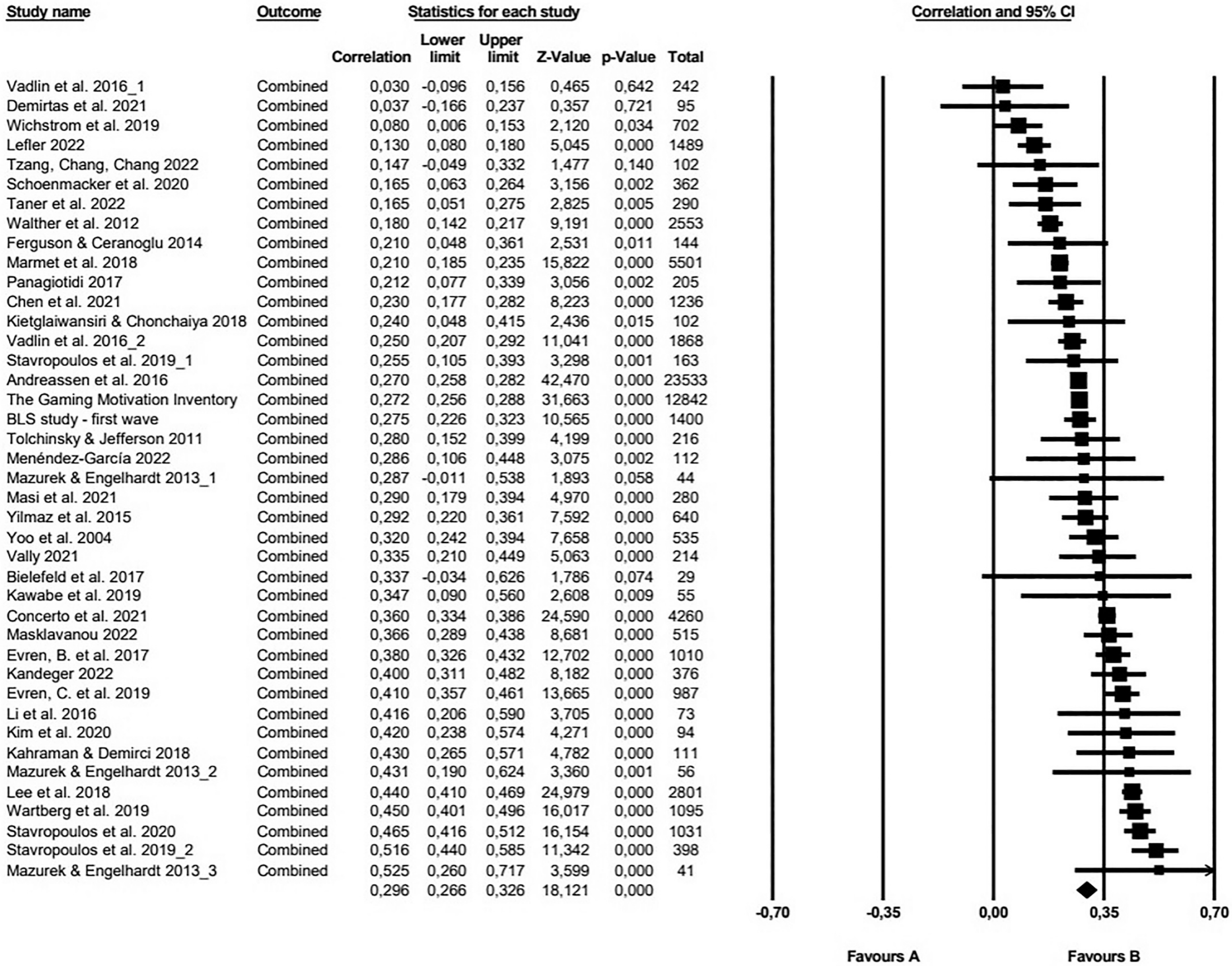
4. Discussion

Data from all available studies focusing on the association between ADHD and GD symptoms were synthesized in the present study to estimate the average size of the relationship, examine the effect of publication bias, and to explore the effect of potential moderators. Based on cross-sectional correlational results, a medium-sized significant positive correlation was found between the two disorders, which was true for the association with both inattention and hyperactivity/impulsivity subdomain scores. A SEM meta-analysis that controlled for the correlation between the two dimensions of ADHD symptoms not only confirmed that both dimensions were related to GD symptoms but also suggested that individuals who exhibit higher levels of GD are likely to experience both hyperactivity/impulsivity and inattention symptoms of ADHD concurrently. This finding suggests a common underlying mechanism or shared risk factors contributing to the co-occurrence of GD and both subtypes of ADHD.

In the meta-analysis of studies applying group comparison, moderate-to-large differences were found in both studies where the GD and non-GD individuals were compared using ADHD symptom severity scores and in studies where ADHD and non-ADHD individuals were compared using GD symptom severity scores. The present study extends the knowledge regarding common GD comorbidities, as previously the co-occurrence of depression and sub-clinical depressive symptoms (Ostinelli et al., 2021) and autism spectrum disorder (Murray et al., 2021) were confirmed using meta-analysis methodology.

The present meta-analysis also provides an overview of the field in regard to the research methods used. We found that the majority of the studies reported cross-sectional results based on self-report. Interestingly, the single study which reported a correlation coefficient based on clinicians' ratings for both ADHD and GD found only a weak relationship, which suggests future studies using professional assessment as opposed to self-report are needed. On the contrary, studies reporting the diagnostic status of participants based on clinicians' ratings found considerable rates of ADHD among patients with GD. We also identified a lack of longitudinal designs and measures based on clinicians' ratings in the field. Therefore, the present results are not informative regarding causality or even the direction of the effect or temporal precedence.

When qualitatively assessing the available six studies regarding longitudinal links, contrasting results were found. Four studies only reported a link between pre-existing ADHD symptoms (especially



Study name	Outcome	Correlation	Lower limit	Upper limit	Z-Value	p-Value	Total
Vadlin et al. 2016_1	Combined	0,030	-0,096	0,156	0,465	0,642	242
Demirtas et al. 2021	Combined	0,037	-0,166	0,237	0,357	0,721	95
Wichstrom et al. 2019	Combined	0,080	0,006	0,153	2,120	0,034	702
Lefler 2022	Combined	0,130	0,080	0,180	5,045	0,000	1489
Tzang, Chang, Chang 2022	Combined	0,147	-0,049	0,332	1,477	0,140	102
Schoenmacker et al. 2020	Combined	0,165	0,063	0,264	3,156	0,002	362
Taner et al. 2022	Combined	0,165	0,051	0,275	2,825	0,005	290
Walther et al. 2012	Combined	0,180	0,142	0,217	9,191	0,000	2553
Ferguson & Ceranoglu 2014	Combined	0,210	0,048	0,361	2,531	0,011	144
Marmet et al. 2018	Combined	0,210	0,185	0,235	15,822	0,000	5501
Panagiotidi 2017	Combined	0,212	0,077	0,339	3,056	0,002	205
Chen et al. 2021	Combined	0,230	0,177	0,282	8,223	0,000	1236
Kietglaiwansiri & Chonchaiya 2018	Combined	0,240	0,048	0,415	2,436	0,015	102
Vadlin et al. 2016_2	Combined	0,250	0,207	0,292	11,041	0,000	1868
Stavropoulos et al. 2019_1	Combined	0,255	0,105	0,393	3,298	0,001	163
Andreassen et al. 2016	Combined	0,270	0,258	0,282	42,470	0,000	23533
The Gaming Motivation Inventory	Combined	0,272	0,256	0,288	31,663	0,000	12842
BLS study - first wave	Combined	0,275	0,226	0,323	10,565	0,000	1400
Tolchinsky & Jefferson 2011	Combined	0,280	0,152	0,399	4,199	0,000	216
Menéndez-García 2022	Combined	0,286	0,106	0,448	3,075	0,002	112
Mazurek & Engelhardt 2013_1	Combined	0,287	-0,011	0,538	1,893	0,058	44
Masi et al. 2021	Combined	0,290	0,179	0,394	4,970	0,000	280
Yilmaz et al. 2015	Combined	0,292	0,220	0,361	7,592	0,000	640
Yoo et al. 2004	Combined	0,320	0,242	0,394	7,658	0,000	535
Vally 2021	Combined	0,335	0,210	0,449	5,063	0,000	214
Bielefeld et al. 2017	Combined	0,337	-0,034	0,626	1,786	0,074	29
Kawabe et al. 2019	Combined	0,347	0,090	0,560	2,608	0,009	55
Concerto et al. 2021	Combined	0,360	0,334	0,386	24,590	0,000	4260
Masklavanou 2022	Combined	0,366	0,289	0,438	8,681	0,000	515
Evren, B. et al. 2017	Combined	0,380	0,326	0,432	12,702	0,000	1010
Kandeger 2022	Combined	0,400	0,311	0,482	8,182	0,000	376
Evren, C. et al. 2019	Combined	0,410	0,357	0,461	13,665	0,000	987
Li et al. 2016	Combined	0,416	0,206	0,590	3,705	0,000	73
Kim et al. 2020	Combined	0,420	0,238	0,574	4,271	0,000	94
Kahraman & Demirci 2018	Combined	0,430	0,265	0,571	4,782	0,000	111
Mazurek & Engelhardt 2013_2	Combined	0,431	0,190	0,624	3,360	0,001	56
Lee et al. 2018	Combined	0,440	0,410	0,469	24,979	0,000	2801
Wartberg et al. 2019	Combined	0,450	0,401	0,496	16,017	0,000	1095
Stavropoulos et al. 2020	Combined	0,465	0,416	0,512	16,154	0,000	1031
Stavropoulos et al. 2019_2	Combined	0,516	0,440	0,585	11,342	0,000	398
Mazurek & Engelhardt 2013_3	Combined	0,525	0,260	0,717	3,599	0,000	41
		0,296	0,266	0,326	18,121	0,000	

Fig. 2. Forest plot for studies with correlation data of the association between gaming disorder symptom severity and combined ADHD scores.

inattention) and later GD symptoms. One study reported evidence for a bidirectional relationship, while the final one reported no longitudinal links. Therefore, it seems that emerging evidence highlights the potential in investigating the co-occurrence of the two disorders. However, future studies with more methodological rigor including longitudinal studies and clinicians' ratings will be needed to (i) confirm this association, and (ii) establish temporal precedence and the direction of the association. Finally, it is recommended that future studies should further investigate whether there is a causal relationship between the two disorders or whether the association is due to common vulnerabilities (e.g., common genetic factors) or confounds (e.g., an overlap in the diagnostic criteria) (Stander, Thomsen, & Highfill-McRoy, 2014).

Even though there are still relatively few data to estimate the effect of potential moderators, the results did not show significant effects of almost any of the moderators, such as age, country, sample type, assessment tool, or informant, and only a negligible effect for gender ratio between GD and combined ADHD symptoms association. This might indicate that the association between GD and ADHD is universal. However, it should be noted that the moderator analyses might have been underpowered due to the relatively small number of studies included in the meta-analysis.

Previous studies have suggested that ADHD and GD are more prevalent among younger populations (Simon et al., 2009; Stevens et al., 2021; Willcutt, 2012). The present study found no proof for the effect of age on the association between the two disorders, and neither for the ADHD sub-domains. Based on these findings, maturation may not lead to a decrease in GD vulnerability among individuals affected by ADHD symptoms. In addition, GD is more prevalent among the male population (Stevens et al., 2021), and ADHD-affected males show higher symptom severity on both subdomains compared to ADHD-affected females (Gershon, 2002), and this factor moderated the association between the two disorders, indicating stronger association for samples where most of the participants were males. However, the related effect estimate was negligible (coefficient = 0.0018, 95% CI = [0.0001; 0.0035], $p < .05$).

Moreover, correlation coefficients calculated from clinical samples did not result in a different estimate of the association as compared to correlation coefficients from non-clinical samples. The study did not find a larger difference in GD symptoms between ADHD and non-ADHD groups, neither when clinical ADHD groups were compared to non-clinical control groups, nor when non-clinical ADHD groups were compared to non-clinical control groups. Testing the effect of culture was only feasible for the association between combined ADHD scores and GD scores between German and Turkish samples. This comparison did not indicate a significant difference in the association between the two countries. However, when interpreting these results, it should be noted that these non-significant results might be due to low statistical power and therefore should be interpreted with caution.

The operationalization of psychological problems can affect

Study name	Outcome	Correlation	Lower limit	Upper limit	Z-Value	p-Value	Total
Vadlin et al. 2016_1	Inattention	-0,020	-0,146	0,106	-0,309	0,757	242
Taner et al. 2022	Inattention	0,130	0,015	0,242	2,215	0,027	290
Lefler 2022	Inattention	0,160	0,110	0,209	6,221	0,000	1489
Walther et al. 2012	Inattention	0,170	0,132	0,207	8,669	0,000	2553
Schoenmacker et al. 2020	Inattention	0,180	0,078	0,278	3,448	0,001	362
Menéndez-García 2022	Inattention	0,220	0,036	0,390	2,335	0,020	112
Marmet et al. 2018	Inattention	0,240	0,215	0,265	18,150	0,000	5501
Kietglaiwansiri & Chonchaiya 2018	Inattention	0,250	0,058	0,424	2,541	0,011	102
Stavropoulos et al. 2019_1	Inattention	0,260	0,111	0,398	3,366	0,001	163
Tzang, Chang, Chang 2022	Inattention	0,270	0,080	0,441	2,755	0,006	102
Peeters et al. 2018	Inattention	0,270	0,190	0,346	6,440	0,000	544
Demirtas et al. 2021	Inattention	0,280	0,083	0,456	2,759	0,006	95
Kawabe et al. 2019	Inattention	0,280	0,016	0,508	2,075	0,038	55
Masi et al. 2021	Inattention	0,280	0,168	0,385	4,788	0,000	280
Vadlin et al. 2016_2	Inattention	0,280	0,238	0,321	12,424	0,000	1868
Panagiotidi 2017	Inattention	0,300	0,170	0,420	4,399	0,000	205
BLS study - first wave	Inattention	0,310	0,262	0,357	11,981	0,000	1400
Vally 2021	Inattention	0,320	0,194	0,435	4,817	0,000	214
Yoo et al. 2004	Inattention	0,350	0,273	0,422	8,429	0,000	535
The Gaming Motivation Inventory study	Inattention	0,360	0,345	0,375	42,705	0,000	12842
Mazurek & Engelhardt 2013_1	Inattention	0,370	0,082	0,601	2,487	0,013	44
Yilmaz et al. 2015	Inattention	0,370	0,301	0,435	9,803	0,000	640
Bielefeld et al. 2017	Inattention	0,400	0,039	0,669	2,160	0,031	29
Evren, B. et al. 2017	Inattention	0,400	0,347	0,451	13,444	0,000	1010
Masklavanou 2022	Inattention	0,410	0,335	0,479	9,857	0,000	515
Kahraman & Demirci 2018	Inattention	0,410	0,242	0,554	4,527	0,000	111
Li et al. 2016	Inattention	0,460	0,257	0,624	4,161	0,000	73
Mazurek & Engelhardt 2013_2	Inattention	0,480	0,248	0,660	3,807	0,000	56
Stavropoulos et al. 2020	Inattention	0,480	0,432	0,526	16,768	0,000	1031
Stavropoulos et al. 2019_2	Inattention	0,480	0,401	0,552	10,394	0,000	398
Mazurek & Engelhardt 2013_3	Inattention	0,550	0,292	0,734	3,812	0,000	41
		0,306	0,266	0,345	14,237	0,000	

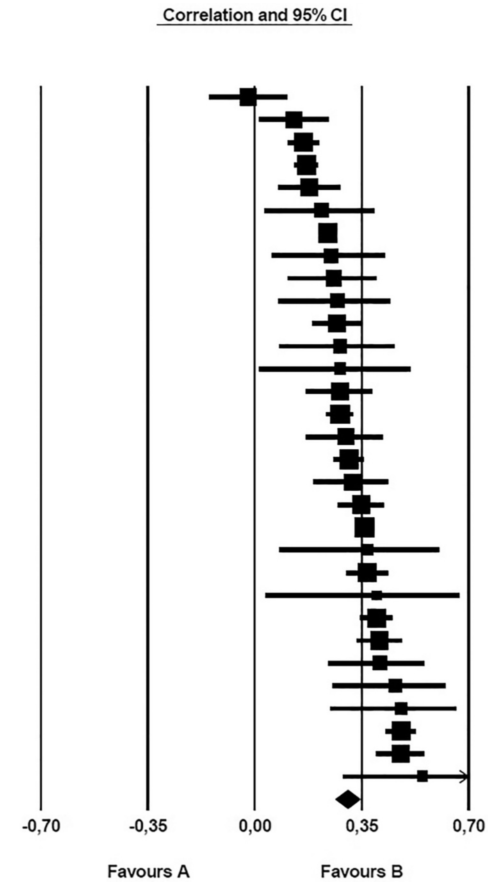


Fig. 3. Forest plot for studies with correlation data of the association between gaming disorder symptom severity and ADHD inattention scores.

Study name	Outcome	Correlation	Lower limit	Upper limit	Z-Value	p-Value	Total
Vadlin et al. 2016_1	Hyperactivity/impulsivity	0,080	-0,047	0,204	1,239	0,215	242
Tzang, Chang, Chang 2022	Hyperactivity/impulsivity	0,020	-0,175	0,214	0,199	0,842	102
Lefler 2022	Hyperactivity/impulsivity	0,100	0,049	0,150	3,868	0,000	1489
Panagiotidi 2017	Hyperactivity/impulsivity	0,120	-0,017	0,253	1,714	0,087	205
Taner et al. 2022	Hyperactivity/impulsivity	0,200	0,087	0,308	3,435	0,001	290
Schoenmacker et al. 2020	Hyperactivity/impulsivity	0,150	0,048	0,249	2,864	0,004	362
Walther et al. 2012	Hyperactivity/impulsivity	0,190	0,152	0,227	9,713	0,000	2553
Marmet et al. 2018	Hyperactivity/impulsivity	0,180	0,154	0,205	13,494	0,000	5501
The Gaming Motivation Inventory study	Hyperactivity/impulsivity	0,180	0,163	0,197	20,620	0,000	12842
Mazurek & Engelhardt 2013_1	Hyperactivity/impulsivity	0,200	-0,103	0,469	1,298	0,194	44
Yilmaz et al. 2015	Hyperactivity/impulsivity	0,210	0,135	0,283	5,380	0,000	640
Vadlin et al. 2016_2	Hyperactivity/impulsivity	0,220	0,176	0,263	9,659	0,000	1868
Menéndez-García 2022	Hyperactivity/impulsivity	0,350	0,176	0,503	3,815	0,000	112
Kietglaiwansiri & Chonchaiya 2018	Hyperactivity/impulsivity	0,230	0,037	0,406	2,330	0,020	102
BLS study - first wave	Hyperactivity/impulsivity	0,240	0,190	0,289	9,149	0,000	1400
Stavropoulos et al. 2019_1	Hyperactivity/impulsivity	0,250	0,100	0,389	3,231	0,001	163
Bielefeld et al. 2017	Hyperactivity/impulsivity	0,270	-0,107	0,579	1,412	0,158	29
Kawabe et al. 2019	Hyperactivity/impulsivity	0,410	0,162	0,609	3,141	0,002	55
Masi et al. 2021	Hyperactivity/impulsivity	0,300	0,189	0,403	5,151	0,000	280
Yoo et al. 2004	Hyperactivity/impulsivity	0,290	0,210	0,366	6,886	0,000	535
Vally 2021	Hyperactivity/impulsivity	0,350	0,227	0,462	5,308	0,000	214
Masklavanou 2022	Hyperactivity/impulsivity	0,320	0,240	0,395	7,504	0,000	515
Evren, B. et al. 2017	Hyperactivity/impulsivity	0,360	0,305	0,413	11,960	0,000	1010
Li et al. 2016	Hyperactivity/impulsivity	0,370	0,153	0,553	3,250	0,001	73
Mazurek & Engelhardt 2013_2	Hyperactivity/impulsivity	0,380	0,130	0,585	2,912	0,004	56
Kahraman & Demirci 2018	Hyperactivity/impulsivity	0,450	0,288	0,587	5,037	0,000	111
Stavropoulos et al. 2020	Hyperactivity/impulsivity	0,450	0,400	0,497	15,541	0,000	1031
Stavropoulos et al. 2019_2	Hyperactivity/impulsivity	0,550	0,478	0,615	12,290	0,000	398
Mazurek & Engelhardt 2013_3	Hyperactivity/impulsivity	0,500	0,227	0,700	3,386	0,001	41
		0,266	0,226	0,305	12,590	0,000	

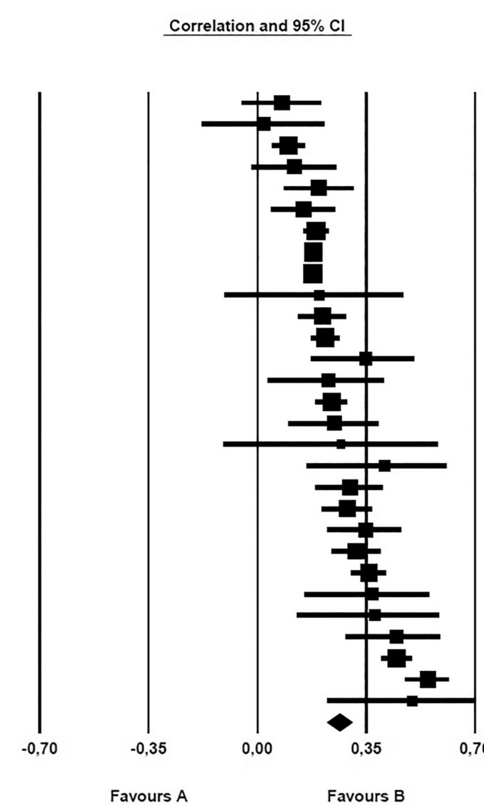


Fig. 4. Forest plot for studies with correlation data of the association between gaming disorder symptom severity and ADHD hyperactivity/impulsivity scores.

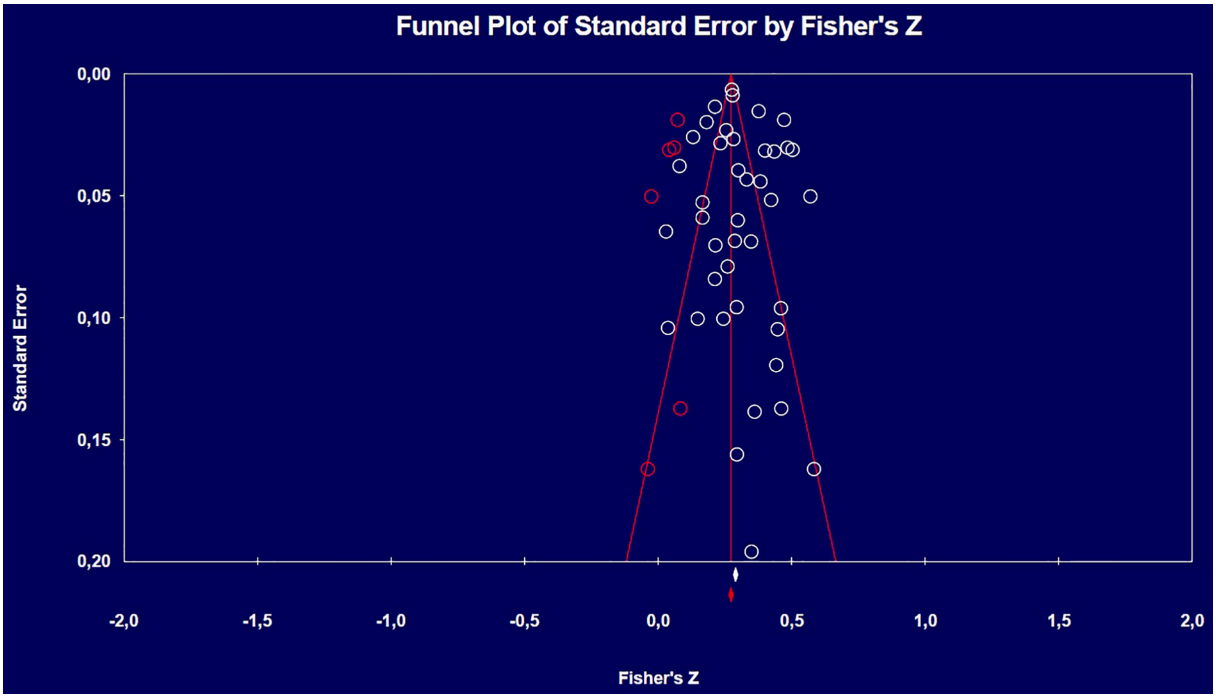


Fig. 5. Funnel plot for studies with correlation data of the association between gaming disorder symptom severity and combined ADHD scores.

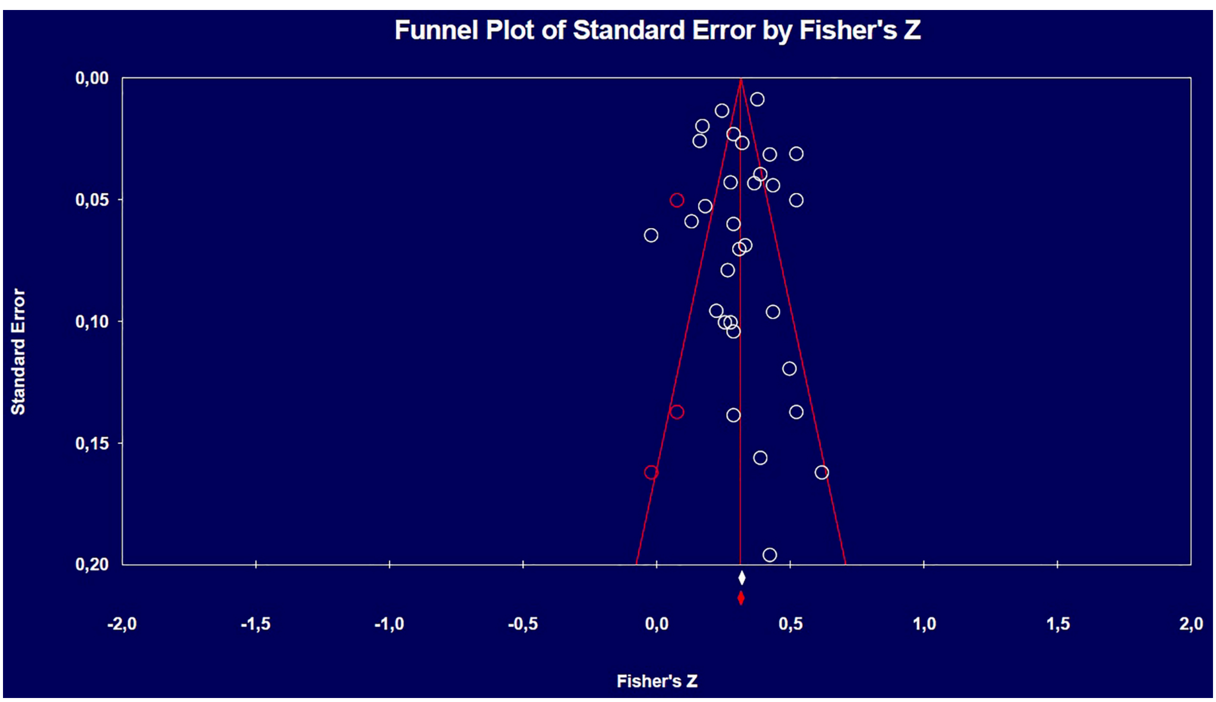


Fig. 6. Funnel plot for studies with correlation data of the association between gaming disorder symptom severity and inattention ADHD scores.

prevalence estimates (Kim et al., 2022). Therefore, the effect of assessment tools, informants, and type of addiction were tested. The most frequently used instruments to assess gaming disorder severity were the Internet Addiction Test (Young, 1998), the Internet Gaming Disorder Scale Short-Form (Pontes & Griffiths, 2015), and the Problem Video Game Playing Scale (Tejeiro Salguero and Morán, 2002). For assessment of ADHD, the most used instruments were the ADHD Rating Scale (DuPaul, Power, Anastopoulos, & Reid, 1998), and the six-item and 18-item Adult Self-Report Scale (Kessler et al., 2005; Ustun et al., 2017), along with parental reports in case of children. The comparison of specific tools or different informants did not produce different estimates for the association between the two disorders, neither for combined ADHD scores, nor for the subdomain scores of ADHD. This is in line with the findings of another meta-analysis, in which the association between ADHD and the problematic use of the internet (PUI) was not affected by the person reporting (i.e., self- vs. parent-rating) (Werling, Kuzhippallil, Emery, Walitza, & Drechsler, 2022).

Since several tools were used to assess problematic use of the

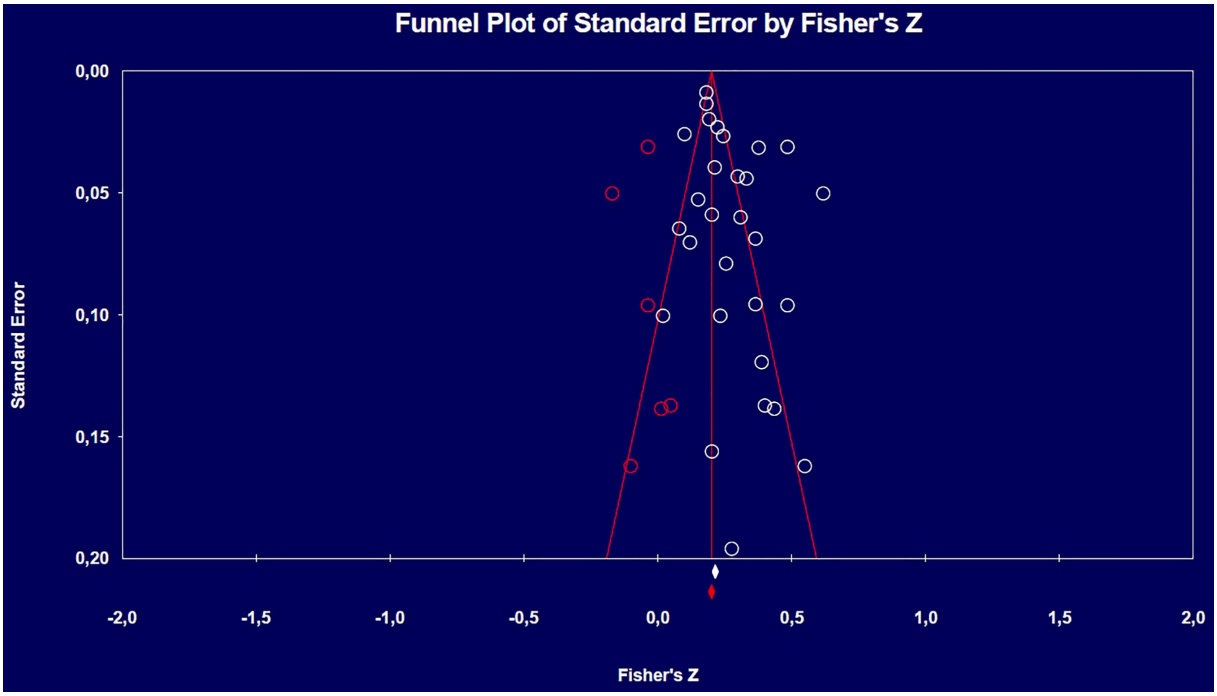


Fig. 7. Funnel plot for studies with correlation data of the association between gaming disorder symptom severity and hyperactivity/impulsivity ADHD S. scores.

Group by GD or mixed GD/IA	Study name	Outcome	Correlation	Lower limit	Upper limit	Z-Value	p-Value	Total
GD	Vadlin et al. 2016_1	Inattention	-0,020	-0,146	0,106	-0,309	0,757	242
GD	Taner et al. 2022	Inattention	0,130	0,015	0,242	2,215	0,027	290
GD	Lefler 2022	Inattention	0,160	0,110	0,209	6,221	0,000	1489
GD	Walther et al. 2012	Inattention	0,170	0,132	0,207	8,669	0,000	2553
GD	Schoenmacker et al. 2020	Inattention	0,180	0,078	0,278	3,448	0,001	362
GD	Menéndez-García 2022	Inattention	0,220	0,036	0,390	2,335	0,020	112
GD	Marmet et al. 2018	Inattention	0,240	0,215	0,265	18,150	0,000	5501
GD	Kietglaiwansiri & Chonchaiya 2018	Inattention	0,250	0,058	0,424	2,541	0,011	102
GD	Stavropoulos et al. 2019_1	Inattention	0,260	0,111	0,398	3,366	0,001	163
GD	Peeters et al. 2018	Inattention	0,270	0,190	0,346	6,440	0,000	544
GD	Masi et al. 2021	Inattention	0,280	0,168	0,385	4,788	0,000	280
GD	Vadlin et al. 2016_2	Inattention	0,280	0,238	0,321	12,424	0,000	1868
GD	Panagiotidi 2017	Inattention	0,300	0,170	0,420	4,399	0,000	205
GD	BLS study - first wave	Inattention	0,310	0,262	0,357	11,981	0,000	1400
GD	Vally 2021	Inattention	0,320	0,194	0,435	4,817	0,000	214
GD	The Gaming Motivation Inventory study	Inattention	0,360	0,345	0,375	42,705	0,000	12842
GD	Mazurek & Engelhardt 2013_1	Inattention	0,370	0,082	0,601	2,487	0,013	44
GD	Masklavanou 2022	Inattention	0,410	0,335	0,479	9,857	0,000	515
GD	Mazurek & Engelhardt 2013_2	Inattention	0,480	0,248	0,660	3,807	0,000	56
GD	Stavropoulos et al. 2019_2	Inattention	0,480	0,401	0,552	10,394	0,000	398
GD	Stavropoulos et al. 2020	Inattention	0,480	0,432	0,526	16,768	0,000	1031
GD	Mazurek & Engelhardt 2013_3	Inattention	0,550	0,292	0,734	3,812	0,000	41
GD			0,288	0,240	0,335	11,245	0,000	
Mixed	Tzang, Chang, Chang 2022	Inattention	0,270	0,080	0,441	2,755	0,006	102
Mixed	Demirtas et al. 2021	Inattention	0,280	0,083	0,456	2,759	0,006	95
Mixed	Kawabe et al. 2019	Inattention	0,280	0,016	0,508	2,075	0,038	55
Mixed	Yoo et al. 2004	Inattention	0,350	0,273	0,422	8,429	0,000	535
Mixed	Yilmaz et al. 2015	Inattention	0,370	0,301	0,435	9,803	0,000	640
Mixed	Bielefeld et al. 2017	Inattention	0,400	0,039	0,669	2,160	0,031	29
Mixed	Evren, B. et al. 2017	Inattention	0,400	0,347	0,451	13,444	0,000	1010
Mixed	Kahraman & Demirci 2018	Inattention	0,410	0,242	0,554	4,527	0,000	111
Mixed	Li et al. 2016	Inattention	0,460	0,257	0,624	4,161	0,000	73
Mixed			0,374	0,340	0,406	20,114	0,000	
Overall			0,344	0,317	0,371	22,856	0,000	

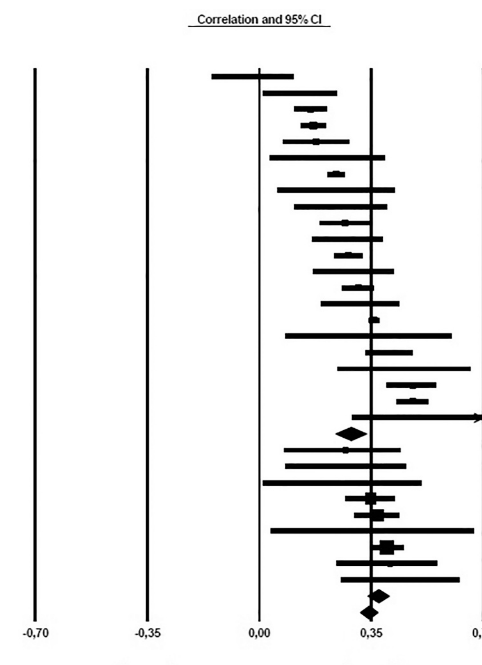


Fig. 8. Forest plot for the comparison of correlation estimates of the association between gaming disorder symptom severity and ADHD inattention scores between studies assessing problematic internet use in predominantly videogame player samples and studies where purely gaming disorder severity was assessed.

internet, most often among samples of gamers, instead of using gaming disorder instruments, the present study compared the potential effect of the disorder type assessed. A significantly stronger association was found between GD symptoms and inattentive symptoms in studies assessing problematic internet use among predominantly videogame player samples compared to studies where only gaming disorder severity was assessed. These results might indicate that the presence of inattentive symptoms of ADHD is a risk factor for the problematic use of numerous other online activities, such as addictive use of social media (Andreassen et al., 2016), online problematic pornography consumption (Bőthe, Koós, Tóth-Király, Orosz, & Demetrovics, 2019), and online problem gambling (Theule, Hurl, Cheung, Ward, & Henrikson, 2019), rather than online gaming only. These findings are in line with the findings of the aforementioned meta-analysis, where the association between ADHD and PUI was explored (Werling et al., 2022).

Finally, we examined the quality of the primary studies as a

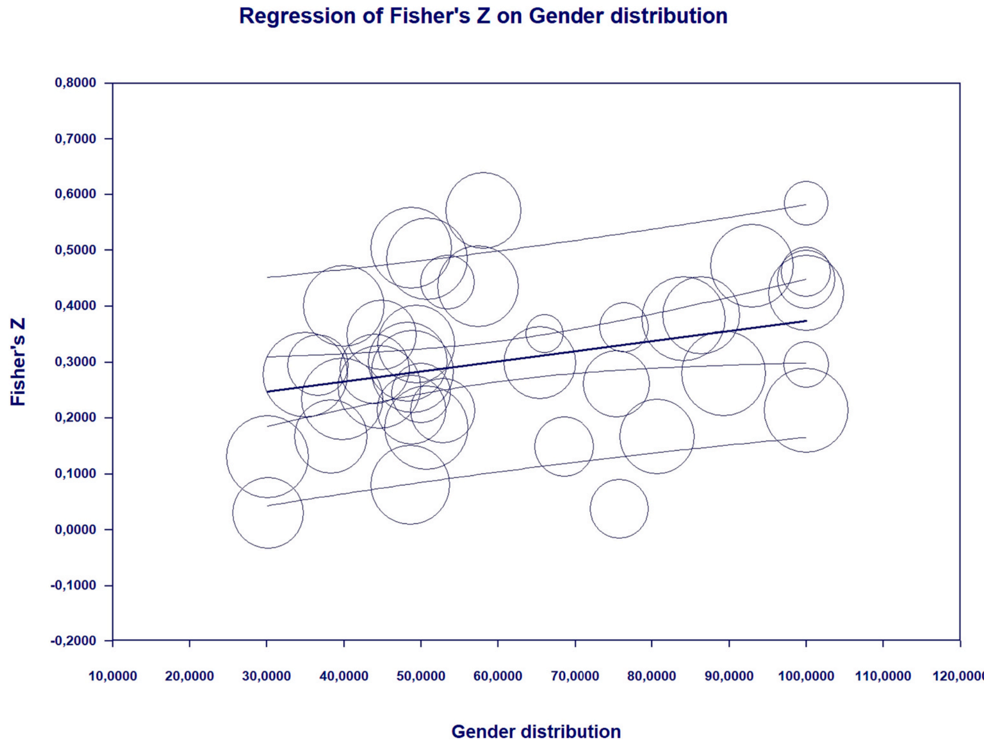


Fig. 9. Meta-regression analysis of gender distribution on correlation estimates between combined ADHD scores and gaming disorder symptom severity.

Table 4
Subgroup analyses results of correlation coefficients using combined ADHD scores.

Moderators	Average effect size							Difference between groups		
	r	k	n	SE	LL	UL	p	Q	df (Q)	p
Sample type										
Clinical	0.255	12	1582	0.0434	0.168	0.338	<0.001			
Non-clinical	0.307	29	66,220	0.0166	0.274	0.339	<0.001			
Total Between								1.288	1	0.256
Country										
Germany	0.324	3	3677	0.1161	0.078	0.533	0.011			
Turkey	0.321	7	3509	0.0385	0.244	0.395	<0.001			
USA	0.338	7	2388	0.0796	0.173	0.485	<0.001			
Total Between								0.035	2	0.983
GD measure										
IAT	0.242	3	685	0.0931	0.051	0.416	0.014			
IGDS9-SF	0.385	10	10,275	0.0265	0.332	0.436	<0.001			
PVP	0.356	6	3363	0.0556	0.243	0.461	<0.001			
Total Between								2.386	2	0.303
GD source										
Parent-report	0.310	6	635	0.0365	0.237	0.380	<0.001			
Self-report	0.300	34	66,465	0.0161	0.269	0.332	<0.001			
Total Between								0.058	1	0.809
ADHD measure										
ADHD-RS	0.349	4	1199	0.0255	0.298	0.398	<0.001			
ASRS-18	0.306	11	32,277	0.0296	0.246	0.363	<0.001			
ASRS-6	0.312	6	21,952	0.0288	0.255	0.368	<0.001			
Total Between								1.484	2	0.476
ADHD source										
Parent-report	0.321	12	2489	0.0449	0.230	0.406	<0.001			
Self-report	0.302	25	63,872	0.0174	0.267	0.335	<0.001			
Total Between								0.158	1	0.691
Type of addiction										
Gaming disorder	0.291	31	65,058	0.0171	0.257	0.324	<0.001			
Internet addiction mixed with GD	0.320	10	2744	0.0314	0.257	0.380	<0.001			
Total Between								0.631	1	0.427

IAT = Internet Addiction Test, IGDS9-SF=Internet Gaming Disorder Scale-9, PVP=Problem Videogame Playing Scale, ADHD-RS = ADHD Rating Scale-IV, ASRS-6 = Adult Self Report Scale-6 (6-item screener), ASRS-18 = Adult Self Report Scale-18. 95% confidence intervals were calculated. CI = confidence interval, LL = lower limit; UL = upper limit, GD = Gaming Disorder, IA = Internet Addiction. Mixed effects analyses results are reported here. 95% confidence intervals were calculated.

Table 5
Subgroup analyses results of correlation coefficients using ADHD inattention scores.

Moderators	Average effect size							Difference between groups		
	r	k	n	SE	LL	UL	*p*	Q	df (Q)	*p*
Sample type										
Clinical	0.265	11	1488	0.0449	0.175	0.351	<0.001			
Non-clinical	0.322	20	31,414	0.0227	0.276	0.365	<0.001			
Total Between								1.293	1	.255
GD measure										
IAT	0.335	3	685	0.0342	0.267	0.401	<0.001			
IGDS9-SF	0.380	6	2865	0.0424	0.294	0.460	<0.001			
Total Between								0.675	1	0.411
GD source										
Parent-report	0.324	6	635	0.0480	0.227	0.415	<0.001			
Self-report	0.302	25	32,267	0.0217	0.259	0.344	<0.001			
Total Between								0.179	1	0.672
ADHD measure										
ADHD-RS	0.375	3	1105	0.0260	0.323	0.425	<0.001			
ASRS-18	0.305	9	4484	0.0584	0.196	0.406	<0.001			
ASRS-6	0.333	3	19,353	0.0464	0.239	0.421	<0.001			
Total Between								1.727	2	0.422
ADHD source										
Parent-report	0.309	9	1156	0.0398	0.229	0.385	<0.001			
Self-report	0.304	19	31,007	0.0245	0.255	0.351	<0.001			
Total Between								0.014	1	0.906
Type of addiction										
Gaming disorder	0.288	22	30,252	0.0242	0.240	0.335	<0.001			
Internet addiction mixed with GD	0.374	9	2650	0.0168	0.340	0.406	<0.001			
Total Between								8.636	1	0.003

IAT = Internet Addiction Test, IGDS9-SF=Internet Gaming Disorder Scale-9, ADHD-RS = ADHD Rating Scale-IV, ASRS-6 = Adult Self Report Scale-6 (6-item screener), ASRS-18 = Adult Self Report Scale-18. 95% confidence intervals were calculated. CI = confidence interval, LL = lower limit; UL = upper limit, GD = Gaming Disorder, IA = Internet Addiction. Mixed effects analyses results are reported here. 95% confidence intervals were calculated.

Table 6
Subgroup analyses results of correlation coefficients using ADHD hyperactivity/impulsivity scores.

Moderators	Average effect size							Difference between groups		
	r	k	n	SE	LL	UL	*p*	Q	df (Q)	*p*
Sample type										
Clinical	0.253	10	1393	0.0477	0.157	0.344	<0.001			
Non-clinical	0.271	19	30,870	0.0230	0.226	0.316	<0.001			
Total Between								0.122	1	0.727
GD source										
Parent-report	0.312	6	635	0.0362	0.239	0.381	<0.001			
Self-report	0.258	23	31,628	0.0217	0.215	0.300	<0.001			
Total Between								1.622	1	0.203
ADHD measure										
ADHD-RS	0.310	3	1105	0.0270	0.256	0.362	<0.001			
ASRS-18	0.296	9	4484	0.0559	0.183	0.402	<0.001			
ASRS-6	0.234	3	19,353	0.0347	0.165	0.301	<0.001			
Total Between								3.025	2	0.220
ADHD source										
Parent-report	0.327	8	1061	0.0475	0.231	0.417	<0.001			
Self-report	0.258	18	30,463	0.0237	0.211	0.304	<0.001			
Total Between								1.624	1	0.202
Type of addiction										
Gaming disorder	0.256	21	29,708	0.0222	0.212	0.299	<0.001			
Internet addiction mixed with GD	0.296	8	2555	0.0408	0.215	0.375	<0.001			
Total Between								0.748	1	0.387

ADHD-RS = ADHD Rating Scale-IV, ASRS-6 = Adult Self Report Scale-6 (6-item screener), ASRS-18 = Adult Self Report Scale-18. 95% confidence intervals were calculated. CI = confidence interval, LL = lower limit; UL = upper limit, GD = Gaming Disorder, IA = Internet Addiction. Mixed effects analyses results are reported here. 95% confidence intervals were calculated.

moderator in addition to the year of data collection. Study quality did not moderate the association between GD and combined ADHD, inattention or hyperactivity/impulsivity symptom severity. In other words, the association found between GD and ADHD in the present meta-analysis cannot be attributed to the quality of studies. Conflicting results were found for the year of data collection. While correlation estimates and ADHD symptom severity differences in group comparison between GD and non-GD individuals were not associated with the year of data collection, newer studies reported larger differences in GD symptom severity between ADHD and non-ADHD individuals. However, as this association was only found in one analysis, it is unclear whether the association may be strengthening over time. The result might simply be the consequence of a confounding variable such as a a different methodology or a trend in different assessment instruments.

Although the present results did not establish causality or even the temporal direction of the association between the two disorders, several underlying mechanisms could be involved. A major factor to explain the association between the two disorders is impulsivity (Li, Zhang, Xiao, &

Table 7
Results of meta-regression analyses on correlation coefficients using combined, inattention and hyperactivity/impulsivity ADHD scores.

Predictor	Coefficient	k	SE	LL	UL	*p*
Combined ADHD						
Mean age	0.0049	38	0.0030	−0.0009	0.0108	0.096
Gender distribution	0.0018	40	0.0008	0.0001	0.0035	0.033
Data collection year	0.0033	41	0.0041	−0.0048	0.0114	0.427
Overall study quality	0.0071	41	0.0136	−0.0196	0.0337	0.600
Inattention						
Mean age	0.0054	30	0.0038	−0.0020	0.0127	0.153
Gender distribution	0.0020	30	0.0011	−0.0002	0.0042	0.079
Data collection year	0.0010	31	0.0048	−0.0084	0.0104	0.834
Overall study quality	0.0189	31	0.0171	−0.0145	0.0523	0.267
Hyperactivity/impulsivity						
Mean age	0.0036	28	0.0038	−0.0038	0.0110	0.338
Gender distribution	0.0006	28	0.0011	−0.0017	0.0025	0.729
Data collection year	0.0015	29	0.0049	−0.0080	0.0110	0.756
Overall study quality	−0.0027	29	0.0163	−0.0347	0.0292	0.867

CI = confidence interval, LL = lower limit; UL = upper limit. Random effects analyses results are reported here. 95% confidence intervals were calculated.

Nie, 2016; Yen et al., 2017). One important characteristic of children with ADHD is the preference of immediate over delayed rewards (delay aversion) (Sonuga-Barke, 2002). Regarding excessive gaming, there is a wide range of experimental neurocognitive studies showing on average a moderate difference in response inhibition between individuals with GD compared to healthy controls (Argyriou, Davison, & Lee, 2017). Lower level of inhibitory control can lead to more hours spent gaming, but impulsive decision-making can also be a consequence of pre-existing GD (Kräplin et al., 2021). Brain imaging studies have also found corresponding evidence of alterations in the prefrontal-striatal circuitry, which may be responsible for the comorbidity through enhanced reward craving and deficits in behavioral control (Gao et al., 2021).

Affective functioning may be another important area of consideration. Patients with comorbid ADHD and GD show more internalizing symptoms, especially withdrawal and depression (Berloffa et al., 2022). A study by Chen, Dai, Shi, Shen, and Ou (2021) demonstrated that depression severity and hopelessness mediated the relationship between the symptoms of the two disorders, and that problematic gaming can lead to progression of disruptive mood dysregulation among patients with ADHD (Tzang, Chang, & Chang, 2022). Patients suffering from both ADHD and GD are also characterized by higher negative urgency (a tendency to immediately react inadequately, when facing negative emotions) (Cabelguen et al., 2021), leading to higher tendency to escape by playing videogames, in an attempt to cope with negative feelings. In addition to the emotional disturbances and maladaptive responsiveness, technology use can also result in higher level of daytime sleepiness for individuals living with ADHD (Bourchtein et al., 2019), potentially affecting the presentation of both GD and ADHD symptoms.

Social functioning among individuals with ADHD, presenting in the form of intrusiveness and aggressivity, has several consequences, such as unpopularity, peer rejection, or lack of reciprocal relationships (Nijmeijer et al., 2008). Social difficulties are a risk factor for GD, as online gaming can be used to compensate for needs that are hard or impossible to satisfy in everyday life (Király, Koncz, Griffiths, & Demetrovics, 2023). In accordance with this, individuals with ADHD, the predominantly inattentive type are often characterized by social anxiety (Koyuncu et al., 2015) and it has been reported that social phobia may

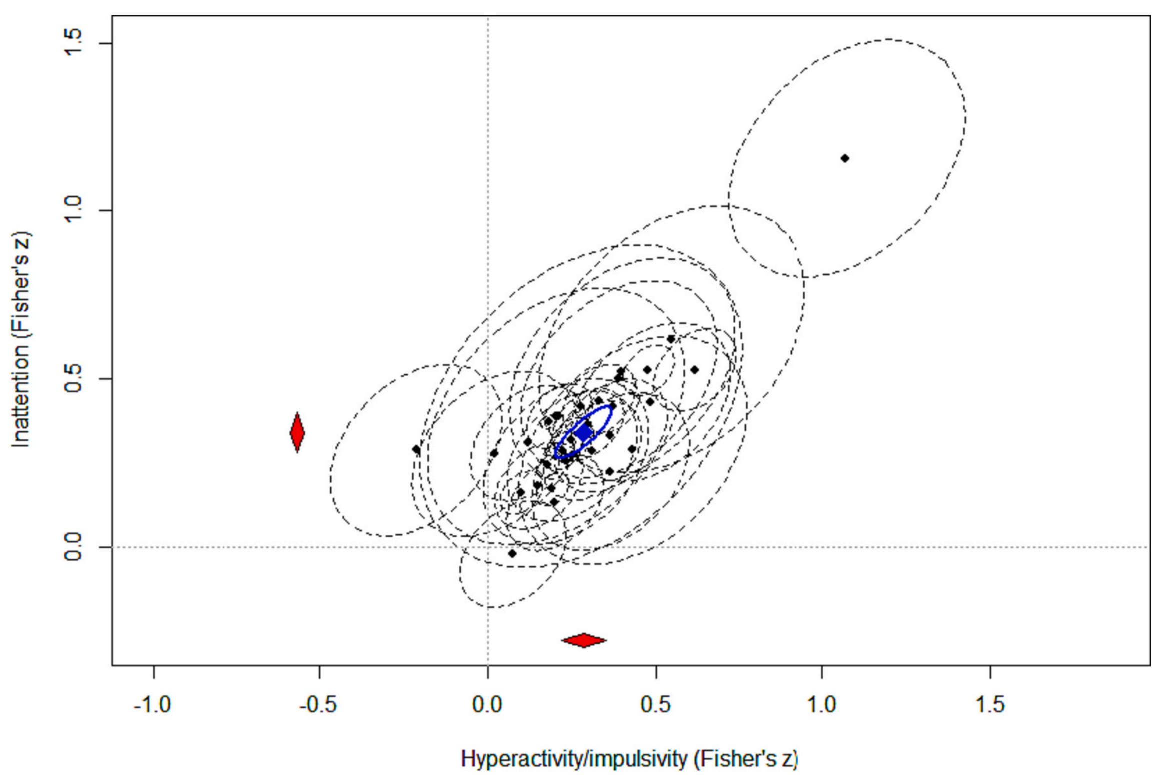


Fig. 10. Univariate and bivariate effects from the SEM meta-analysis model.
The plot shows the individual effect sizes (black dots) and their confidence intervals (dashed ellipses). Red diamonds show the univariate effects, blue diamond shows the bivariate effect with a confidence interval (blue ellipsis). Both outcomes have a significant positive pooled effect, and there is a strong positive within-studies correlation between the two effects.

Study name	Outcome	Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
		Statistics for each study						
Kwak et al. 2020	IGD/IA symptom severity	0,068	0,381	0,145	-0,679	0,815	0,179	0,858
Gentile 2009	IGD/IA symptom severity	0,355	0,089	0,008	0,179	0,530	3,965	0,000
Paulus et al. 2018	IGD/IA symptom severity	0,506	0,109	0,012	0,292	0,720	4,637	0,000
Basgül et al. 2020	IGD/IA symptom severity	0,796	0,146	0,021	0,509	1,083	5,438	0,000
Weinstein et al. 2015	IGD/IA symptom severity	0,801	0,206	0,043	0,397	1,206	3,882	0,000
Razjouyan et al. 2020	IGD/IA symptom severity	1,009	0,150	0,023	0,714	1,304	6,709	0,000
Evren, C. et al. 2021	IGD/IA symptom severity	1,028	0,097	0,009	0,838	1,217	10,632	0,000
		0,693	0,129	0,017	0,440	0,945	5,377	0,000

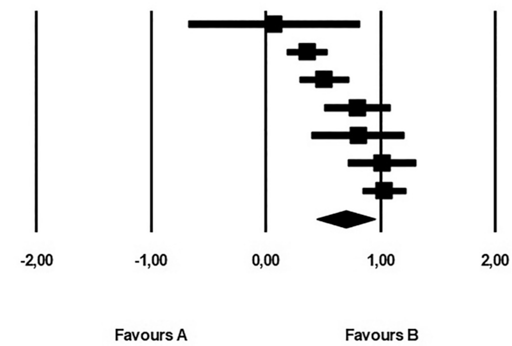


Fig. 11. Forest plot for studies with gaming disorder symptom severity differences between ADHD and non-ADHD groups.

Study name		Hedges's g	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value	IGD group	Non-IGD group
		Statistics for each study							Sample size	
Melek & Eroglu 2019	Combined	0,287	0,143	0,021	0,006	0,568	2,001	0,045	100	95
Starcevic et al. 2020	Combined	0,450	0,209	0,044	0,040	0,860	2,152	0,031	36	64
Cao & Su 2007	Combined	0,646	0,180	0,033	0,292	0,999	3,580	0,000	64	64
Berloffa 2022	Combined	0,719	0,198	0,039	0,330	1,108	3,624	0,000	48	60
Pearcy et al. 2017	Combined	0,959	0,225	0,051	0,518	1,401	4,263	0,000	22	263
Pearcy et al. 2017	Combined	1,257	0,314	0,099	0,642	1,873	4,003	0,000	12	107
Seong et al. 2019	Combined	1,697	0,137	0,019	1,429	1,966	12,406	0,000	152	138
		0,854	0,226	0,051	0,411	1,297	3,776	0,000		

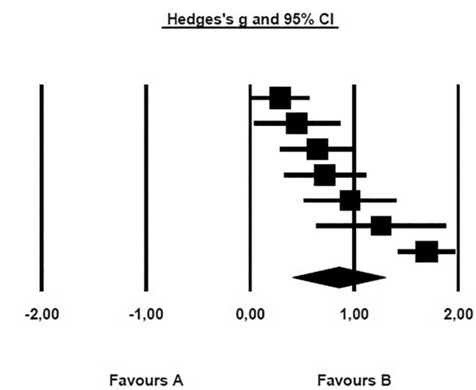


Fig. 12. Forest plot for studies with combined ADHD score differences between GD and non-GD groups.

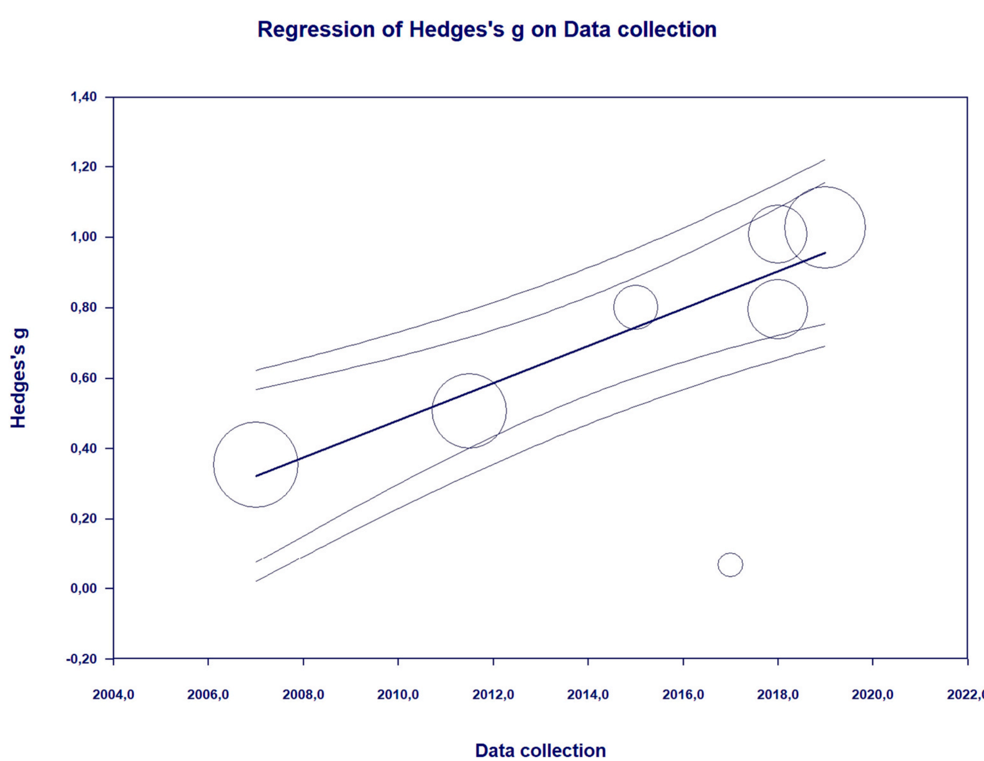


Fig. 13. Meta-regression analysis of data collection date on gaming disorder symptom severity differences between ADHD and non-ADHD groups.

Table 8
Results of meta-regression analyses on Hedges's g values using gaming disorder symptom severity scores in case of comparison between ADHD and non-ADHD groups and combined ADHD scores in case of comparison between GD and non-GD groups.

Predictor	Coefficient	k	SE	LL	UL	*p*
Gaming disorder severity						
Mean age	0.0301	5	0.0208	−0.0107	0.0709	0.148
Gender distribution	0.0099	6	0.0066	−0.0029	0.0228	0.130
Data collection year	0.0528	7	0.0118	0.0296	0.0760	<0.001
Overall study quality	−0.0297	7	0.1454	−0.3148	0.2554	0.838
Combined ADHD						
Mean age	0.0501	6	0.0345	−0.0175	0.1178	0.146
Gender distribution	0.0047	7	0.0160	−0.0267	0.0361	0.771
Data collection year	0.0108	7	0.0524	−0.0918	0.1135	0.836
Overall study quality	0.1841	6	0.2773	−0.3594	0.7277	0.501

CI = confidence interval, LL = lower limit; UL = upper limit. Random effects analyses results are reported here. 95% confidence intervals were calculated.

contribute to a higher risk of developing problematic internet use among individuals with ADHD (Demirtaş, Alnak, & Coşkun, 2021). The pure ADHD sample-based studies by Chou et al. (2015, 2016) also support this hypothesis. Both dissatisfaction with family relationships and social skill deficits are associated with a heightened risk for problematic internet use. Moreover, low self-esteem has also been found to be predictive of comorbidity between ADHD and GD (Cabelguen et al., 2021).

Volkow et al. (2011) reported that D2/D3 dopamine receptor availability may be responsible for motivation deficits among individuals with ADHD. Boredom proneness is a characteristic associated with symptoms of ADHD (Malkovsky, Merrifield, Goldberg, & Danckert, 2012). Therefore, one idea is that individuals with ADHD may have a greater need for highly stimulating activities, such as playing videogames (Chou, Chang, & Yen, 2018) to reach an optimal level of arousal (Dullur et al., 2021; Paulus et al., 2018). The higher tendency of individuals with ADHD for immersion into playing videogames may be one factor contributing to greater vulnerability for problematic use (Jung et al., 2020), which may be a manifestation of ADHD-related hyperfocus (Hupfeld, Abagis, & Shah, 2019). Findings from brain neuroimaging studies show decreased gray matter volume and lower activity among patients with both GD and ADHD in the insula, which may be responsible for the lower cognitive control, increased distractibility, and motivational deficits typical in ADHD and habituation to gaming-related cues and desensitization to conventional stimuli in GD (Gao et al., 2021).

4.1. Limitations

While the present meta-analysis aimed to synthesize evidence from different research designs, most of them were cross-sectional studies using self-report measures. Consequently, it was only these that could be quantitatively synthesized. Only six studies reported longitudinal associations, and these had conflicting results. Therefore, neither causality nor the direction of effect can be determined using the available data. It is possible that ADHD symptoms may cause the emergence of gaming disorder, or it is also possible that gaming (or problematic gaming) may cause ADHD symptoms. Alternatively, a bi-directional association is also possible, as proposed by Marmet et al. (2018). However, another possible explanation is that a third factor may explain the co-occurrence of the two disorders, such as impaired decision-making or self-regulation (which can be the result of a previously present deficit in the ventromedial prefrontal cortex; Schettler, Thomasius, & Paschke, 2022), or common vulnerabilities such as genetic risks.

The large-scale methodological heterogeneity found between studies led to some difficulties in analysis and interpretation. Most of the studies included in the meta-analysis comprised correlation coefficients because these types of data were reported most often, while some studies, where mostly clinical groups of ADHD or GD individuals were compared to control groups, reported mean differences and standard deviations. Therefore, these types of data were not suitable to be merged into one analysis, which led to lower numbers of studies in all three data analysis types.

Furthermore, as a result of the methodological heterogeneity in categorical data (e.g., use of different assessment tools or the implementation of a scale in modified format), running subgroup analysis was not possible on the studies reporting group comparisons. It was only feasible in case of some categorical moderators for correlations. Finally, there were relatively few studies resulting in the possibility of low statistical power. This was especially the case for moderator analyses where only a few studies could be included. Therefore, non-significant results should be interpreted with caution.

5. Conclusion

Overall, the study found small-to-large associations between the symptoms of gaming disorder and both attention-deficit/hyperactivity disorder subdomains (inattention and hyperactivity/impulsivity) and combined ADHD symptom severity. A stronger association was found between ADHD inattentive symptoms and GD symptom severity among studies assessing problematic internet use in predominantly videogame player samples compared to studies where only gaming disorder severity was assessed. Similarly, the significant effect of year of data collection was only found in one analysis (i.e., when GD symptom severity was compared between individuals with ADHD and those without). All studies were rated medium-to-high quality as far as cross-sectional studies were concerned. However, the results show that there is a great need for longitudinal studies to establish temporal precedence and the direction of the effect, in addition to assessment based on clinicians' ratings or diagnosis.

The use of robust psychometric instruments suitable for cross-culturally comparison is highly recommended, such as the IGDT-10 (Király et al., 2019, 2017) or the IGDS-9SF (Pontes & Griffiths, 2015). Moderator analyses should be run again in the future, when more data are available in the different categories (sample type, country, assessment tool, informant, type of disorder examined). Although the present results highlight the co-occurrence of GD and ADHD, further research with more rigorous methodology is needed to confirm the association and investigate the temporal direction and possible causation. On a practical note, screening of both disorders is recommended in the presence of either.

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Contributors

Conceptualization of the study was by PK and ZD. The planning and execution of database searches was carried out by OK and PK. Screening for eligibility was carried out by PK in collaboration with PhD and MA students. Training of coders and raters (data collection) was performed by PK, while also frequently being a rater or coder. Data analysis was carried out by PK, ZKT, and NT. The original draft of the manuscript was written by PK, which was edited, commented and revised by OK, ZKT,

Table 9
Quality assessment of studies with correlation analysis results.

Study	Research question	Research design rating	Research design	Sampling/ selection bias	Reliability of ADHD measure	Reliability of GD/IA measure	Overall quality score
Andreassen et al. (2016)	2	2	Cross-sectional	1.5	2	2	9.5
Bielefeld et al. (2017)	2	1.5	Cross-sectional	1	2	2	8.5
BLS study, unpublished	2	2	Longitudinal	2	1	2	9
Chen et al. (2021)	2	2	Cross-sectional	1.5	2	2	9.5
Concerto et al. (2021)	1	2	Cross-sectional	1	2	2	8
Demirtaş et al. (2021)	1.5	1.5	Cross-sectional	1.5	2	2	8.5
Evren, B. et al. (2018)	2	1.5	Cross-sectional	1.5	2	2	9
Evren, C. et al. (2019)	2	2	Cross-sectional	2	2	2	10
Ferguson & Ceranoglu (2014)	1.5	2	Longitudinal	1	2	1	7.5
Jung et al. (2020)	2	1.5	Cross-sectional	1	2	2	8.5
Kahraman & Demirci (2018)	2	2	Cross-sectional	1	1	2	8
Kandeğer & Egilmez (2022)	2	1.5	Cross-sectional	1	2	2	8.5
Kawabe et al. (2019)	1	1	Cross-sectional	1	2	2	7
Kietglaiwansiri & Chonchaiya (2018)	1	1.5	Cross-sectional	1	2	2	7.5
Kim et al. (2020)	2	2	Cross-sectional	1.5	2	2	9.5
Lee et al. (2018)	1	1.5	Cross-sectional	1.5	2	2	8
Lefler et al. (2023)	2	2	Cross-sectional	1.5	2	1.5	9
Li et al. (2016)	2	2	Cross-sectional	1.5	2	2	9.5
Marmet et al. (2018)	2	2	Longitudinal	2	2	2	10
Masi et al. (2021)	1.5	1.5	Cross-sectional	1.5	1.5	1	7
Masklavanou et al. (2022)	1	1	Cross-sectional	1	2	2	7
Mazurek & Engelhardt (2013)	2	1.5	Cross-sectional	1	2	1	7.5
Menendez-García et al. (2022)	0	2	Cross-sectional	1.5	0	0.5	4
Panagiotidi (2017)	1	1.5	Cross-sectional	0	2	1	5.5
Peeters et al. (2018)	2	2	Longitudinal	1	2	2	9
Schoenmacker et al. (2020)	2	2	Longitudinal	1.5	0.5	1	8.5
Stavropoulos et al. (2019)	2	2	Cross-sectional	1.5	2	2	9.5
Stavropoulos et al. (2020)	2	1.5	Cross-sectional	2	2	2	9.5
Taner et al. (2022)	1	1	Cross-sectional	1	2	1	6
Király et al. (2022)	1.5	2	Cross-sectional	2	2	2	9.5
Tolchinsky & Jefferson (2011)	2	2	Cross-sectional	0.5	1	1	6.5
Tzang et al. (2022)	2	2	Cross-sectional	2	2	1.5	9.5
Vadlin et al. (2016)	2	2	Cross-sectional	1	1.5	2	8.5
Vally (2021)	1	1.5	Cross-sectional	1.5	2	2	8
Walther et al. (2012)	2	2	Cross-sectional	2	1	1.5	8.5
Wartberg et al. (2019)	2	2	Longitudinal	2	1	2	9
Wichstrøm et al. (2019)	2	2	Longitudinal	2	2	1.5	9.5
Yılmaz et al. (2015)	2	2	Cross-sectional	2	2	2	10
Yoo et al. (2004)	2	2	Cross-sectional	2	2	1	9

Table 10
Quality assessment of studies with group comparison results between ADHD and non-ADHD participants.

Study	Research question	Research design rating	Research design	Sampling/selection bias	Reliability of ADHD measure	Reliability of GD/IA measure	Overall quality score
Başgül et al. (2020)	1	2	Cross-sectional	2	2	0.5	7.5
Evren, C. et al. (2021)	2	2	Cross-sectional	1.5	2	2	9.5
Gentile (2009)	2	2	Cross-sectional	2	1.5	0.5	8
Kwak et al. (2020)	2	2	Longitudinal	1	2	2	9
Paulus et al. (2018)	1.5	2	Cross-sectional	2	2	0.5	8
Razjouyan et al. (2020)	0.5	1.5	Cross-sectional	0.5	2	2	6.5
Weinstein et al. (2015)	2	2	Cross-sectional	1	2	2	9

Table 11
Quality assessment of studies with group comparison results between GD and non-GD participants.

Study	Research question	Research design rating	Research design	Sampling/selection bias	Reliability of ADHD measure	Reliability of GD/IA measure	Overall quality score
Berloffa et al. (2022)	1	1.5	Cross-sectional	1	2	2	7.5
Cao & Su (2007)	1.5	2	Cross-sectional	2	1	1	7.5
Melek & Eroğlu (2019)	1	2	Cross-sectional	1.5	2	2	8.5
Pearcy et al. (2017)	2	1.5	Cross-sectional	1	2	2	8.5
Seong et al. (2019)	2	2	Cross-sectional	2	2	2	10
Starcevic et al. (2020)	2	2	Cross-sectional	2	2	2	10

MDG, ZD, and NT. The submission and formatting of the manuscript for the specific journal guidelines was the responsibility of PK.

Pre-registration

The present study was pre-registered on the OSF site (https://osf.io/rj5t6), which was updated before data extraction started (https://osf.io/7vugz).

Open data

The database used in the present study can be found online on the Open Science framework site [dataset](Koncz et al., 2022).

Koncz, P., Király, O., Demetrovics, Zs., (2022). Examination of the relationship between gaming disorder (GD) and attention deficit hyperactivity disorder (ADHD): a meta-analysis [dataset]. Open Science Framework. https://osf.io/ufr93/

Declaration of Competing Interest

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Data availability

We have shared the link to the data on the title page (Open Data section).

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References

Aarseth, E., Bean, A. M., Boonen, H., Carras, M. C., Coulson, M., Das, D., … Van Rooij, A. J. (2017). Scholars' open debate paper on the World Health Organization ICD-11 gaming disorder proposal. *Journal of Behavioral Addictions, 6*(3), 267–270.

Alimoradi, Z., Lotfi, A., Lin, C.-Y., Griffiths, M. D., & Pakpour, A. H. (2022). Estimation of behavioral addiction prevalence during COVID-19 pandemic: A systematic review and meta-analysis. *Current Addiction Reports, 9*, 486–517. https://doi.org/10.1007/s40429-022-00435-6

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). American Psychiatric Publishing.

Andreassen, C. S., Billieux, J., Griffiths, M. D., Kuss, D. J., Demetrovics, Z., Mazzoni, E., & Pallesen, S. (2016). The relationship between addictive use of social media and video games and symptoms of psychiatric disorders: A large-scale cross-sectional study. *Psychology of Addictive Behaviors, 30*(2), 252–262.

Argyriou, E., Davison, C. B., & Lee, T. T. (2017). Response inhibition and internet gaming disorder: A meta-analysis. *Addictive Behaviors, 71*, 54–60. https://doi.org/10.1016/j.addbeh.2017.02.026

Başgül, Ş. S., Bekar, B., & Luş, M. G. (2020). Associations between computer game addiction and attention deficit and hyperactivity disorder - An emprical study. *Addicta: The Turkish Journal on Addictions, 7*(2), 122–128.

Berloffa, S., Salvati, A., D'acunto, G., Fantozzi, P., Inguaggiato, E., Lenzi, F., … Masi, G. (2022). Internet gaming disorder in children and adolescents with attention deficit hyperactivity disorder. *Children, 9*(3), 428. https://doi.org/10.3390/children9030428

Bielefeld, M., Drews, M., Putzig, I., Bottel, L., Steinbüchel, T., Dieris-Hirche, J., … Theodor te Wildt, B. (2017). Comorbidity of Internet use disorder and attention deficit hyperactivity disorder: Two adult case–control studies. *Journal of Behavioral Addictions, 6*(4), 490–504.

Billieux, J., King, D. L., Higuchi, S., Achab, S., Bowden-Jones, H., Hao, W., … Saunders, J. B. (2017). Functional impairment matters in the screening and diagnosis of gaming disorder: Commentary on: Scholars' open debate paper on the World Health Organization ICD-11 gaming disorder proposal (Aarseth et al.). *Journal of Behavioral Addictions, 6*(3), 267–270. https://doi.org/10.1556/2006.6.2017.036

Billieux, J., Schimmenti, A., Khazaal, Y., Maurage, P., & Heeren, A. (2015). Are we overpathologizing everyday life? A tenable blueprint for behavioral addiction research. *Journal of Behavioral Addictions, 4*(3), 119–123.

Borenstein, M., Hedges, L. V., Higgins, J. P., & Rothstein, H. R. (2009). *Introduction to meta-analysis*. John Wiley.

Bőthe, B., Koós, M., Tóth-Király, I., Orosz, G., & Demetrovics, Z. (2019). Investigating the associations of adult ADHD symptoms, hypersexuality, and problematic pornography use among men and women on a largescale, non-clinical sample. *The Journal of Sexual Medicine, 16*(4), 489–499.

Bourchtein, E., Langberg, J. M., Cusick, C. N., Breaux, R. P., Smith, Z. R., & Becker, S. P. (2019). Featured article: Technology use and sleep in adolescents with and without attention-deficit/hyperactivity disorder. *Journal of Pediatric Psychology, 44*(5), 517–526.

Bozkurt, H., Coskun, M., Ayaydin, H., Adak, I., & Zoroglu, S. S. (2013). Prevalence and patterns of psychiatric disorders in referred adolescents with internet addiction. *Psychiatry and Clinical Neurosciences, 67*(5), 352–359.

Cabelguen, C., Rocher, B., Leboucher, J., Schreck, B., Challet-Bouju, G., Hardouin, J.-B., & Grall-Bronnec, M. (2021). Attention deficit hyperactivity disorder and gaming disorder: Frequency and associated factors in a clinical sample of patients with gaming disorder. *Journal of Behavioral Addictions, 10*(4), 1061–1067.

Cao, F., & Su, L. (2007). Internet addiction among Chinese adolescents: Prevalence and psychological features. *Child: Care, Health and Development, 33*(3), 275–281.

Castro-Calvo, J., King, D. L., Stein, D. J., Brand, M., Carmi, L., Chamberlain, S. R., … Yücel, M. (2021). Expert appraisal of criteria for assessing gaming disorder: An international Delphi study. *Addiction, 116*(9), 2463–2475.

Chen, C., Dai, S., Shi, L., Shen, Y., & Ou, J. (2021). Associations between attention deficit/hyperactivity disorder and internet gaming disorder symptoms mediated by depressive symptoms and hopelessness among college students. *Neuropsychiatric Disease and Treatment, 17*, 2775.

Cheung, M. W. L., & Chan, W. (2009). A two-stage approach to synthesizing covariance matrices in meta-analytic structural equation modeling. *Structural Equation Modeling, 16*(1), 28–53. https://doi.org/10.1080/10705510802561295

Chou, W. J., Chang, Y. P., & Yen, C. F. (2018). Boredom proneness and its correlation with internet addiction and internet activities in adolescents with attention-deficit/hyperactivity disorder. *The Kaohsiung Journal of Medical Sciences, 34*(8), 467–474.

Chou, W. J., Huang, M. F., Chang, Y. P., Chen, Y. M., Hu, H. F., & Yen, C. F. (2016). Social skills deficits and their association with internet addiction and activities in adolescents with attention-deficit/hyperactivity disorder. *Journal of Behavioral Addictions, 6*(1), 42–50.

Chou, W. J., Liu, T. L., Yang, P., Yen, C. F., & Hu, H. F. (2015). Multi-dimensional correlates of internet addiction symptoms in adolescents with attention-deficit/hyperactivity disorder. *Psychiatry Research, 225*(1–2), 122–128.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Erlbaum.

Collett, B. R., Ohan, J. L., & Myers, K. M. (2003). Ten-year review of rating scales. V: Scales assessing attention-deficit/hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry, 42*(9), 1015–1037.

Concerto, C., Rodolico, A., Avanzato, C., Fusar-Poli, L., Signorelli, M. S., Battaglia, F., & Aguglia, E. (2021). Autistic traits and attention-deficit hyperactivity disorder symptoms predict the severity of internet gaming disorder in an Italian adult population. *Brain Sciences, 11*(6), 774.

Demirtaş, O. O., Alnak, A., & Coşkun, M. (2021). Lifetime depressive and current social anxiety are associated with problematic internet use in adolescents with ADHD: A cross-sectional study. *Child and Adolescent Mental Health, 26*(3), 220–227.

Dullur, P., Krishnan, V., & Diaz, A. M. (2021). A systematic review on the intersection of attention-deficit hyperactivity disorder and gaming disorder. *Journal of Psychiatric Research, 133*, 212–222.

DuPaul, G. J., Power, T. J., Anastopoulos, A. D., & Reid, R. (1998). *ADHD rating scale—IV: Checklists, norms, and clinical interpretation*. Guilford Press.

Duval, S., & Tweedie, R. (2000). Trim and fill: A simple funnel-plot–based method of testing and adjusting for publication bias in meta-analysis. *Biometrics, 56*, 455–463.

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. *BMJ, 315*, 629–634.

Vadlin, S., Åslund, C., Hellström, C., & Nilsson, K. W. (2016). Associations between problematic gaming and psychiatric symptoms among adolescents in two samples. *Addictive Behaviors, 61*, 8–15.

Vally, Z. (2021). Symptoms of internet gaming disorder, inattention, and impulsivity: A cross-sectional study conducted in the United Arab Emirates. *Psychiatric Quarterly, 92*(1), 301–310.

van Emmerik-van Oortmerssen, K., van de Glind, G., van den Brink, W., Smit, F., Crunelle, C. L., Swets, M., & Schoevers, R. A. (2012). Prevalence of attention-deficit hyperactivity disorder in substance use disorder patients: A meta-analysis and meta-regression analysis. *Drug and Alcohol Dependence, 122*(1–2), 11–19.

Evren, B., Evren, C., Dalbudak, E., Topcu, M., & Kutlu, N. (2018). Relationship of internet addiction severity with probable ADHD and difficulties in emotion regulation among young adults. *Psychiatry Research, 269*, 494–500.

Evren, C., Evren, B., Dalbudak, E., Topcu, M., & Kutlu, N. (2019). Relationships of Internet addiction and Internet gaming disorder symptom severities with probable attention deficit/hyperactivity disorder, aggression and negative affect among university students. *ADHD Attention Deficit and Hyperactivity Disorders, 11*(4), 413–421.

Evren, C., Evren, B., Dalbudak, E., Topcu, M., & Kutlu, N. (2021). The relationship between probable ADHD and playing MMORPGs with the severity of disordered gaming: The effect of gaming motivations. *Dusunen Adam, 34*(2), 200–211.

Ferguson, C. J., & Ceranoglu, T. A. (2014). Attention problems and pathological gaming: Resolving the 'chicken and egg' in a prospective analysis. *Psychiatric Quarterly, 85*(1), 103–110.

Ferguson, C. J., & Colwell, J. (2020). Lack of consensus among scholars on the issue of video game "addiction". *Psychology of Popular Media, 9*(3), 359–366. https://doi.org/10.1037/ppm0000243

Galanis, C. R., Delfabbro, P. H., & King, D. L. (2021). Stigma-related arguments against gaming disorder: A call for research. *Addiction, 116*(10), 2921–2922. https://doi.org/10.1111/add.15561

Gao, X., Zhang, M., Yang, Z., Wen, M., Huang, H., Zheng, R., … Zhang, Y. (2021). Structural and functional brain abnormalities in internet gaming disorder and attention-deficit/hyperactivity disorder: a comparative meta-analysis. *Frontiers in Psychiatry, 12*. https://doi.org/10.3389/fpsyt.2021.679437. Article 679437.

Gentile, D. (2009). Pathological video-game use among youth ages 8 to 18: A national study. *Psychological Science, 20*(5), 594–602.

Gershon, J. (2002). A meta-analytic review of gender differences in ADHD. *Journal of Attention Disorders, 5*(3), 143–154.

González-Bueso, V., Santamaría, J. J., Fernández, D., Merino, L., Montero, E., & Ribas, J. (2018). Association between internet gaming disorder or pathological video-game use and comorbid psychopathology: A comprehensive review. *International Journal of Environmental Research and Public Health, 15*(4), 668.

Griffiths, M. D., van Rooij, A. J., Kardefelt-Winther, D., Starcevic, V., Király, O., Pallesen, S., … Demetrovics, Z. (2016). Working towards an international consensus on criteria for assessing Internet Gaming Disorder: A critical commentary on Petry et al (2014). *Addiction, 111*(1), 167–175.

Han, D. H., Yoo, M., Renshaw, P. F., & Petry, N. M. (2018). A cohort study of patients seeking internet gaming disorder treatment. *Journal of Behavioral Addictions, 7*(4), 930–938.

Harrer, M., Cuijpers, P., Furukawa, T. A., & Ebert, D. D. (2021). *Doing Meta-Analysis with R*. CRC Press. https://doi.org/10.1201/9781003107347

Hupfeld, K. E., Abagis, T. R., & Shah, P. (2019). Living "in the zone": Hyperfocus in adult ADHD. *ADHD Attention Deficit and Hyperactivity Disorders, 11*, 191–208. https://doi.org/10.1007/s12402-018-0272-y

Jeong, H., Yim, H. W., Lee, S.-Y., Lee, H. K., Potenza, M. N., Jo, S.-J., … Kim, G. (2020). Low self-control and aggression exert serial mediation between inattention/hyperactivity problems and severity of internet gaming disorder features longitudinally among adolescents. *Journal of Behavioral Addictions, 9*(2), 401–409.

Jung, D., Shim, E. J., Park, H., Lee, K., Lee, S., Kim, E. Y., … Hahm, B. J. (2020). The association between excessive internet gaming behavior and immersive tendency, mediated by attention deficit/hyperactivity disorder symptoms, in Korean male university students. *Psychiatry Investigation, 17*(5), 403–411.

Kahraman, Ö., & Demirci, E.Ö. (2018). Internet addiction and attention-deficit-hyperactivity disorder: Effects of anxiety, depression and self-esteem. *Pediatrics International, 60*(6), 529–534.

Kandeğer, A., & Egilmez, Ü. (2022). Dissociative Absorption May Contribute to Internet Gaming Disorder Independent of Childhood Trauma and ADHD Symptoms Among Male University Students. *The Eurasian Journal of Medicine, 54*(3), 259–263.

Karaca, S., Saleh, A., Canan, F., & Potenza, M. N. (2017). Comorbidity between behavioral addictions and attention deficit/hyperactivity disorder: A systematic review. *International Journal of Mental Health and Addiction, 15*(3), 701–724.

Kawabe, K., Horiuchi, F., Miyama, T., Jogamoto, T., Aibara, K., Ishii, E., & Ueno, S. I. (2019). Internet addiction and attention-deficit/hyperactivity disorder symptoms in adolescents with autism spectrum disorder. *Research in Developmental Disabilities, 89*, 22–28.

Kessler, R. C., Adler, L., Ames, M., Demler, O., Faraone, S., Hiripi, E. V. A., … Walters, E. E. (2005). The World Health Organization adult ADHD self-report scale (ASRS): A short screening scale for use in the general population. *Psychological Medicine, 35*(2), 245–256.

Kietglaiwansiri, T., & Chonchaiya, W. (2018). Pattern of video game use in children with attention-deficit-hyperactivity disorder and typical development. *Pediatrics International, 60*(6), 523–528.

Kim, H. S., Son, G., Roh, E. B., Ahn, W. Y., Kim, J., Shin, S. H., … Choi, K. H. (2022). Prevalence of gaming disorder: A meta-analysis. *Addictive Behaviors, 126*, 107183.

Kim, M., Kim, D., Bae, S., Han, D. H., & Jeong, B. (2020). Aberrant structural network of comorbid attention deficit/hyperactivity disorder is associated with addiction severity in internet gaming disorder. *NeuroImage: Clinical, 27*, 102263.

King, D. L., Chamberlain, S. R., Carragher, N., Billieux, J., Stein, D., Mueller, K., … Delfabbro, P. H. (2020). Screening and assessment tools for gaming disorder: A comprehensive systematic review. *Clinical Psychology Review, 77*, 101831.

King, D. L., Haagsma, M. C., Delfabbro, P. H., Gradisar, M., & Griffiths, M. D. (2013). Toward a consensus definition of pathological video-gaming: A systematic review of psychometric assessment tools. *Clinical Psychology Review, 33*(3), 331–342.

Király, O., Billieux, J., King, D. L., Urbán, R., Koncz, P., Polgár, E., & Demetrovics, Z. (2022). A comprehensive model to understand and assess the motivational background of video game use: The gaming motivation inventory (GMI). *Journal of Behavioral Addictions*. https://doi.org/10.1556/2006.2022.00048

Király, O., Bőthe, B., Ramos-Diaz, J., Rahimi-Movaghar, A., Lukavska, K., Hrabec, O., … Demetrovics, Z. (2019). Ten-item internet gaming disorder test (IGDT-10): Measurement invariance and cross-cultural validation across seven language-based samples. *Psychology of Addictive Behaviors, 33*(1), 91–103.

Király, O., Griffiths, M. D., & Demetrovics, Z. (2015). Internet gaming disorder and the DSM-5: Conceptualization, debates, and controversies. *Current Addiction Reports, 2*(3), 254–262.

Király, O., Koncz, P., Griffiths, M. D., & Demetrovics, Z. (2023). Gaming disorder: A summary of its characteristics and aetiology. *Comprehensive Psychiatry, 122*, 152376. https://doi.org/10.1016/j.comppsych.2023.152376

Király, O., Sleczka, P., Pontes, H. M., Urbán, R., Griffiths, M. D., & Demetrovics, Z. (2017). Validation of the ten-item internet gaming disorder test (IGDT-10) and evaluation of the nine DSM-5 internet gaming disorder criteria. *Addictive Behaviors, 64*, 253–260. https://doi.org/10.1016/j.addbeh.2015.11.005

Ko, C. H., Király, O., Demetrovics, Z., Chang, Y. M., & Yen, J. Y. (2020). Identifying individuals in need of help for their uncontrolled gaming: A narrative review of concerns and comments regarding gaming disorder diagnostic criteria. *Journal of Behavioral Addictions, 9*(3), 572–588. https://doi.org/10.1556/2006.2020.00058

Koyuncu, A., Ertekin, E., Yüksel, Ç., Aslantaş Ertekin, B., Çelebi, F., Binbay, Z., & Tükel, R. (2015). Predominantly inattentive type of ADHD is associated with social anxiety disorder. *Journal of Attention Disorders, 19*(10), 856–864.

Kräplin, A., Scherbaum, S., Kraft, E. M., Rehbein, F., Bühringer, G., Goschke, T., & Mößle, T. (2021). The role of inhibitory control and decision-making in the course of internet gaming disorder. *Journal of Behavioral Addictions, 9*(4), 990–1001.

Kwak, K. H., Hwang, H. C., Kim, S. M., & Han, D. H. (2020). Comparison of behavioral changes and brain activity between adolescents with internet gaming disorder and student pro-gamers. *International Journal of Environmental Research and Public Health, 17*(2), 441.

Laconi, S., Rodgers, R. F., & Chabrol, H. (2014). The measurement of internet addiction: A critical review of existing scales and their psychometric properties. *Computers in Human Behavior, 41*, 190–202.

Lee, H. J., Tran, D. D., & Morrell, H. E. (2018). Smoking, ADHD, and problematic video game use: A structural modeling approach. *Cyberpsychology, Behavior, and Social Networking, 21*(5), 281–286.

Lefler, E. K., Alacha, H. F., Vasko, J. M., Serrano, J. W., Looby, A., Flory, K., & Hartung, C. M. (2023). Sex differences in ADHD symptoms, problematic gaming, and impairment in college students. *Current Psychology, 42*, 26836–26847. https://doi.org/10.1007/s12144-022-03469-1

Li, W., Zhang, W., Xiao, L., & Nie, J. (2016). The association of internet addiction symptoms with impulsiveness, loneliness, novelty seeking and behavioral inhibition system among adults with attention-deficit/hyperactivity disorder (ADHD). *Psychiatry Research, 243*, 357–364.

Malkovsky, E., Merrifield, C., Goldberg, Y., & Danckert, J. (2012). Exploring the relationship between boredom and sustained attention. *Experimental Brain Research, 221*, 59–67. https://doi.org/10.1007/s00221-012-3147-z

Marmet, S., Studer, J., Grazioli, V. S., & Gmel, G. (2018). Bidirectional associations between self-reported gaming disorder and adult attention deficit hyperactivity disorder: Evidence from a sample of young Swiss men. *Frontiers in Psychiatry, 9*, 649.

Masi, L., Abadie, P., Herba, C., Emond, M., Gingras, M. P., & Amor, L. B. (2021). Video games in ADHD and non-ADHD children: Modalities of use and association with ADHD Symptoms. *Frontiers in Pediatrics, 9*, 632272. https://doi.org/10.3389/fped.2021.632272

Masklavanou, C., Triantafyllou, K., Paparrigopoulos, T., Sypsa, V., & Pehlivanidis, A. (2022). Internet gaming disorder, exercise and attention deficit hyperactivity disorder: the role of symptoms of depression, anxiety and stress. *Psychiatrike, 34*(1), 13–19.

Mazurek, M. O., & Engelhardt, C. R. (2013). Video game use in boys with autism spectrum disorder, ADHD, or typical development. *Pediatrics, 132*(2), 260–266.

Melek, L. U.Ş., & Eroğlu, M. Z. (2019). Internet addiction among adolescents with attention-deficit/hyperactivity disorder. *Cukurova Medical Journal, 44*, 140–147.

Menendez-García, A., Jiménez-Arroyo, A., Rodrigo-Yanguas, M., Marin-Vila, M., Sánchez-Sánchez, F., Roman-Riechmann, E., & Blasco-Fontecilla, H. (2022). Internet, video game and mobile phone addiction in children and adolescents: A case-control study. *Adicciones, 34*(3), 208–216.

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group*. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement. *Annals of Internal Medicine, 151*(4), 264–269.

Murray, A., Koronczai, B., Király, O., Griffiths, M. D., Mannion, A., Leader, G., & Demetrovics, Z. (2021). Autism, problematic internet use and gaming disorder: A systematic review. *Review Journal of Autism and Developmental Disorders, 9*, 120–130.

Nijmeijer, J. S., Minderaa, R. B., Buitelaar, J. K., Mulligan, A., Hartman, C. A., & Hoekstra, P. J. (2008). Attention-deficit/hyperactivity disorder and social dysfunctioning. *Clinical Psychology Review, 28*(4), 692–708.

Ostinelli, E. G., Zangani, C., Giordano, B., Maestri, D., Gambini, O., D'Agostino, A., … Purgato, M. (2021). Depressive symptoms and depression in individuals with internet gaming disorder: A systematic review and meta-analysis. *Journal of Affective Disorders, 284*, 136–142.

Panagiotidi, M. (2017). Problematic video game play and ADHD traits in an adult population. *Cyberpsychology, Behavior, and Social Networking, 20*(5), 292–295.

Paulus, F. W., Sinzig, J., Mayer, H., Weber, M., & von Gontard, A. (2018). Computer gaming disorder and ADHD in young children — A population-based study. *International Journal of Mental Health and Addiction, 16*(5), 1193–1207.

Pearcy, B. T., McEvoy, P. M., & Roberts, L. D. (2017). Internet gaming disorder explains unique variance in psychological distress and disability after controlling for comorbid depression, OCD, ADHD, and anxiety. *Cyberpsychology, Behavior, and Social Networking, 20*(2), 126–132.

Peeters, M., Koning, I., & van den Eijnden, R. (2018). Predicting Internet Gaming Disorder symptoms in young adolescents: A one-year follow-up study. *Computers in Human Behavior, 80*, 255–261.

Pontes, H. M., & Griffiths, M. D. (2015). Measuring DSM-5 internet gaming disorder: Development and validation of a short psychometric scale. *Computers in Human Behavior, 45*, 137–143.

Protzko, J. (2020). Kids These Days! Increasing delay of gratification ability over the past 50 years in children. *Intelligence, 80*, 101451.

Razjouyan, K., Khademi, M., Dorandish, Z. Y., & Davari-Ashtiani, R. (2020). An investigation into the frequency of addiction to video games in children with attention-deficit hyperactivity disorder. *Journal of Family Medicine and Primary Care, 9*(2), 669.

Rosenthal, R. (1979). The file drawer problem and tolerance for null results. *Psychological Bulletin, 86*, 638–6141.

Savard, J., Hirvikoski, T., Görts Öberg, K., Dhejne, C., Rahm, C., & Jokinen, J. (2021). Impulsivity in compulsive sexual behavior disorder and pedophilic disorder. *Journal of Behavioral Addictions, 10*(3), 839–847.

Schettler, L., Thomasius, R., & Paschke, K. (2022). Neural correlates of problematic gaming in adolescents: A systematic review of structural and functional magnetic resonance imaging studies. *Addiction Biology, 27*(1), Article e13093.

Schoenmacker, G. H., Groenman, A., Sokolova, E., Oosterlaan, J., Rommelse, N., Roeyers, H., … Buitelaar, J. K. (2020). Role of conduct problems in the relation between attention-deficit hyperactivity disorder, substance use, and gaming. *European Neuropsychopharmacology, 30*, 102–113.

Seong, W., Hong, J. S., Kim, S., Kim, S. M., & Han, D. H. (2019). Personality and psychological factors of problematic internet gamers seeking hospital treatment. *Frontiers in Psychiatry, 10*, 583.

Simon, V., Czobor, P., Bálint, S., Mészáros, A., & Bitter, I. (2009). Prevalence and correlates of adult attention-deficit hyperactivity disorder: Meta-analysis. *British Journal of Psychiatry, 194*(3), 204–211.

Sonuga-Barke, E. J. (2002). Psychological heterogeneity in AD/HD—A dual pathway model of behaviour and cognition. *Behavioural Brain Research, 130*(1–2), 29–36.

Stander, V. A., Thomsen, C. J., & Highfill-McRoy, R. M. (2014). Etiology of depression comorbidity in combat-related PTSD: A review of the literature. *Clinical Psychology Review, 34*(2), 87–98.

Starcevic, V., Choi, T. Y., Kim, T. H., Yoo, S. K., Bae, S., Choi, B. S., & Han, D. H. (2020). Internet gaming disorder and gaming disorder in the context of seeking and not seeking treatment for video-gaming. *Journal of Psychiatric Research, 129*, 31–39.

Stavropoulos, V., Adams, B. L., Beard, C. L., Dumble, E., Trawley, S., Gomez, R., & Pontes, H. M. (2019). Associations between attention deficit hyperactivity and internet gaming disorder symptoms: Is there consistency across types of symptoms, gender and countries? *Addictive Behaviors Reports, 9*, 100158.

Stavropoulos, V., Baynes, K. L., O'Farrel, D. L., Gomez, R., Mueller, A., Yucel, M., & Griffiths, M. (2020). Inattention and disordered gaming: Does culture matter? *Psychiatric Quarterly, 91*(2), 333–348.

Stevens, M. W., Dorstyn, D., Delfabbro, P. H., & King, D. L. (2021). Global prevalence of gaming disorder: A systematic review and meta-analysis. *The Australian and New Zealand Journal of Psychiatry, 55*(6), 553–568.

Taner, H. A., Sarı, B. A., Kulaçoğlu, K. C., Mayalık, A., Mecit, H., Özekicioğlu, K., & Zorbaz, Z. O. (2022). Internet gaming disorder's correspondence with attention deficit hyperactivity disorder and game/in-game purchases among university students. *Entertainment Computing, 42*, 100486.

Taylor, A., Deb, S., & Unwin, G. (2011). Scales for the identification of adults with attention deficit hyperactivity disorder (ADHD): A systematic review. *Research in Developmental Disabilities, 32*(3), 924–938.

Tejeiro Salguero, R. A., & Morán, R. M. B. (2002). Measuring problem video game playing in adolescents. *Addiction, 97*(12), 1601–1606.

Theule, J., Hurl, K. E., Cheung, K., Ward, M., & Henrikson, B. (2019). Exploring the relationships between problem gambling and ADHD: A meta-analysis. *Journal of Attention Disorders, 23*(12), 1427–1437.

Thomas, R., Sanders, S., Doust, J., Beller, E., & Glasziou, P. (2015). Prevalence of attention-deficit/hyperactivity disorder: A systematic review and meta-analysis. *Pediatrics, 135*(4), e994–e1001.

Tolchinsky, A., & Jefferson, S. D. (2011). Problematic video game play in a college sample and its relationship to time management skills and attention-deficit/hyperactivity disorder symptomology. *Cyberpsychology, Behavior, and Social Networking, 14*(9), 489–496.

Tzang, R. F., Chang, C. H., & Chang, Y. C. (2022). Structural equation modeling (SEM): Gaming disorder leading untreated attention-deficit/hyperactivity disorder to disruptive mood dysregulation. *International Journal of Environmental Research and Public Health, 19*(11), 6648.

Ustun, B., Adler, L. A., Rudin, C., Faraone, S. V., Spencer, T. J., Berglund, P., … Kessler, R. C. (2017). The World Health Organization adult attention-deficit/hyperactivity disorder self-report screening scale for DSM-5. *JAMA Psychiatry, 74*(5), 520–526.

Van Rooij, A. J., Schoenmakers, T. M., & Van de Mheen, D. (2017). Clinical validation of the C-VAT 2.0 assessment tool for gaming disorder: A sensitivity analysis of the proposed DSM-5 criteria and the clinical characteristics of young patients with 'video game addiction'. *Addictive Behaviors, 64*, 269–274. https://doi.org/10.1016/j.addbeh.2015.10.018

Volkow, N. D., Wang, G. J., Newcorn, J. H., Kollins, S. H., Wigal, T. L., Telang, F., … Swanson, J. M. (2011). Motivation deficit in ADHD is associated with dysfunction of the dopamine reward pathway. *Molecular Psychiatry, 16*(11), 1147–1154.

Walther, B., Morgenstern, M., & Hanewinkel, R. (2012). Co-occurrence of addictive behaviours: personality factors related to substance use, gambling and computer gaming. *European Addiction Research, 18*(4), 167–174.

Wartberg, L., Kriston, L., Zieglmeier, M., Lincoln, T., & Kammerl, R. (2019). A longitudinal study on psychosocial causes and consequences of internet gaming disorder in adolescence. *Psychological Medicine, 49*(2), 287–294.

Weinstein, A., Yaacov, Y., Manning, M., Danon, P., & Weizman, A. (2015). Internet addiction and attention deficit hyperactivity disorder among schoolchildren. *The Israel Medical Association Journal: IMAJ, 17*(12), 731–734.

Werling, A. M., Kuzhippallil, S., Emery, S., Walitza, S., & Drechsler, R. (2022). Problematic use of digital media in children and adolescents with a diagnosis of attention-deficit/hyperactivity disorder compared to controls. A meta-analysis. *Journal of Behavioral Addictions, 11*(2), 305–325.

Wichstrøm, L., Stenseng, F., Belsky, J., von Soest, T., & Hygen, B. W. (2019). Symptoms of internet gaming disorder in youth: predictors and comorbidity. *Journal of Abnormal Child Psychology, 47*(1), 71–83.

Willcutt, E. G. (2012). The prevalence of DSM-IV attention-deficit/hyperactivity disorder: A meta-analytic review. *Neurotherapeutics, 9*(3), 490–499.

World Health Organization. (2019). ICD-11: International Classification of Diseases (11th revision). https://icd.who.int/browse11/l-m/en#/http://id.who.int/icd/entity/1448597234.

Yen, J. Y., Liu, T. L., Wang, P. W., Chen, C. S., Yen, C. F., & Ko, C. H. (2017). Association between internet gaming disorder and adult attention deficit and hyperactivity disorder and their correlates: Impulsivity and hostility. *Addictive Behaviors, 64*, 308–313. https://doi.org/10.1016/j.addbeh.2016.04.024

Yılmaz, S., Hergüner, S., Bilgiç, A., & Işık, Ü. (2015). Internet addiction is related to attention deficit but not hyperactivity in a sample of high school students. *International journal of psychiatry in clinical practice, 19*(1), 18–23.

Yoo, H. J., Cho, S. C., Ha, J., Yune, S. K., Kim, S. J., Hwang, J., … Lyoo, I. K. (2004). Attention deficit hyperactivity symptoms and internet addiction. *Psychiatry and clinical neurosciences, 58*(5), 487–494.

Young, K. S. (1998). *Caught in the net: How to recognize the signs of internet addiction-and a winning strategy for recovery*. John Wiley & Sons.