ESTUDOS DE PSICOLOGIA
Psychological Studies

REVIEW ARTICLE

Health Psychology

Editor
Raquel Souza Lobo Guzzo

Support
This research was supported by the São Paulo Research Foundation (Fapesp), (Process nº 2020/12313-7) and *Conselho Nacional de Pesquisa e Desenvolvimento* (CNPq) (Process nº 303163/2020-8).

Conflict of interest
The authors declare they have no conflict of interests.

Received
Mach 24, 2022

Final version
November 9, 2022

Approved
February 3, 2023

The association between gaming disorder and impulsivity: A systematic review

Associação entre transtornos por jogos eletrônicos e impulsividade: uma revisão sistemática

André Luiz Monezi Andrade[1], Fernanda Beatriz Hodar Lobato[1], Naomi Stange[2], Adriana Scatena[3], Wanderlei Abadio de Oliveira[1], Hyoun S. Kim[3], Fernanda Machado Lopes[4]

[1] Pontifícia Universidade Católica de Campinas (PUC-Campinas), Escola de Ciências da Vida, Programa de Pós-Graduação em Psicologia. Campinas, SP, Brasil. Correspondence to: A. L. M. ANDRADE. E-mail: <andre.andrade@puc-campinas.edu.br>.

[2] Universidade Federal de São Paulo, Departamento de Psicobiologia. São Paulo, SP, Brasil.

[3] Toronto Metropolitan Univeristy, Department of Psychology. Toronto, ON, Canadá.

[4] Universidade Federal de Santa Catarina, Centro de Filosofia e Ciências Humanas, Programa de Pós-Graduação em Psicologia. Florianópolis, SC, Brasil.

How to cite this article: Andrade, A. L. M., Lobato, F. B. H., Stange, N., Scatena, A., Oliveira, W. A., Kim, H. S., & Lopes, F. M. (2024). The association between gaming disorder and impulsivity: A systematic review. *Estudos de Psicologia* (Campinas), *41*, e220032. https://doi.org/10.1590/1982-0275202441e220032

Abstract

Objective

Impulsivity has been robustly linked to various addictions, including behavioral addictions. This systematic review aimed to investigate possible relationships between impulsivity and gaming disorder.

Method

A total of 1,710 empirical studies, without date or language restrictions, were retrieved from *Biblioteca Virtual em Saúde*, Cumulative Index to Nursing and Allied Health Literature, PubMed, PsycNET, Scopus, and Web of Science databases. In total, 16 studies met the inclusion criteria and were included for extraction, quantitative analysis, and integrative synthesis.

Results

Overall, a positive association was observed between gaming disorder and both self-reported measures of impulsivity and behavioral measures of impulsivity. Gaming disorder was associated with the presence of high-risk trends, high sensitivity to rewards, reduced inhibitory control, and low self-control among video game players.

Conclusion

The present systematic review provides preliminary support for the robust association between impulsivity and gaming disorder. However, given the methodological heterogeneity in assessment instruments and statistical procedures, the identified association should be interpreted cautiously.

Keywords: Impulsive behavior; Internet addiction disorder; Systematic review; Video games.

Resumo

Objetivo

A impulsividade tem estado fortemente ligada a vários tipos de dependência, incluindo as dependências comportamentais. Esta revisão sistemática visou investigar possíveis relações entre a impulsividade e o transtorno por jogos eletrônicos.

Método

Um total de 1.710 estudos empíricos, sem restrições de data ou linguagem, foram recuperados das bases de dados Biblioteca Virtual em Saúde, Cumulative Index to Nursing and Allied Health Literature, PubMed, PsycNET, Scopus, e Web of Science. No total, 16 estudos preencheram os critérios de inclusão e foram incluídos para extração, análise quantitativa, e síntese integrativa.

Resultados

Observou-se uma associação positiva entre o transtorno por jogos eletrônicos e as medidas de impulsividade e de comportamento de impulsividade autorrelatadas. O transtorno por jogos eletrônicos foi associado à presença de tendências de alto risco, alta sensibilidade às recompensas, controle inibitório reduzido, e baixo autocontrole entre os jogadores.

Conclusão

A presente revisão fornece apoio preliminar para uma associação robusta entre a impulsividade e o transtorno por jogos eletrônicos. Contudo, dada a heterogeneidade metodológica nos instrumentos de avaliação e procedimentos estatísticos, esta associação deve ser interpretada com cautela.

Palavras-chave: *Comportamento impulsivo; Transtorno de adição à internet; Revisão sistemática; Jogos de vídeo.*

As video games have grown in popularity over the past decade, it has become increasingly necessary to understand their effect on players' psychological well-being (Şalvarlı & Griffiths, 2022). Video games are available on many devices, making them easily accessible, especially to younger people (Mylona et al., 2020; Snodgrass et al., 2019). Some authors have identified that exposure to video games and the internet is occurring at increasingly earlier ages, which could be related to emotional and behavioral problems (Andrade, Enumo et al., 2021; Andrade, Kim et al., 2021; Breda et al., 2014; Hisam et al., 2018). The excessive use of video games has been recognized as a formal diagnosis in current manuals and is classified as "Internet Gaming Disorder" in the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2013) and as Gaming Disorder (G.D.) in the International Classification of Diseases (World Health Organization, 2018).

The G.D. has multiple determinants, including biological, environmental, social, and emotional factors (Cruz et al., 2018; Ferreira & Sartes, 2018; Lemos et al., 2014). Furthermore, G.D highly co-occurs with other psychological conditions and traits such as aggression (Andrade et al., 2020; Breda et al., 2014; Johnson et al., 2017; Sarmet & Pilati, 2016; Staude-Müller, 2011; Von Der Heiden et al., 2019; Wei et al., 2012), anxiety and depression (Bavelier et al., 2011; Breda et al., 2014; Johnson et al., 2017; Miguel et al., 2017; Von Der Heiden et al., 2019; Wei et al., 2012), social phobia (Bavelier et al., 2011), attention deficit hyperactivity disorder (Breda et al., 2014; Wei et al., 2012), and substance use disorder (Johnson et al., 2017). Among the clinical conditions listed, these are commonly associated with difficulty controlling impulses, which may result in negative impairments in various life domains.

The prevalence of G.D. is significantly higher among males, and video gamers exhibit two predominant personality traits: impulsivity and sensation-seeking. Impulsivity is a multi-dimensional construct and encompasses behavioral and cognitive aspects (McCloskey et al., 2009; Romer, 2010), with increased impulsivity being associated with maladaptive conditions such as novelty-

seeking (McCloskey et al., 2009; Romer, 2010), difficulties with self-control, persistence, and self-regulation (Liau et al., 2015; Nuyens et al., 2016; Ryu et al., 2018), low self-esteem (Lemos et al., 2014), interpersonal skill deficits (Lemos et al., 2014), delay discounting (Enticott et al., 2006; Liau et al., 2015), risk-taking without prior planning (McCloskey et al., 2009; Romer, 2010), decision-making difficulties (Nuyens et al., 2016), and the sense of urgency, impatience, and temporal perception (McCloskey et al., 2009; Romer, 2010). Some authors have detected a causal relationship between impulsivity and G.D., such that higher levels of impulsivity are associated with a raised risk of G.D. (Mestre-Bach et al., 2018).

Considering the relationship between impulsivity and internet addiction (Cheng et al., 2021) and the gap in the literature synthesizing the studies investigating the relationship between impulsivity and G.D. (Breda et al., 2014), the present review aimed to investigate possible relationships between impulsivity and G.D. We hypothesized that (i) G.D. would be positively associated with impulsivity; and (ii) impulsivity would be a predictor for G.D.

Method

This systematic review followed the updated guidelines set by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021; Lopes et al., 2022; Bedendo et al., 2018). Three experts designed the protocol for this study and were prospectively registered on the International Prospective Register of Systematic Reviews platform (CRD42020181912). All three experts have a Ph.D. and are researchers in impulse disorders, with expertise in systematic reviews, meta-analysis, and behavioral addictions.

The following steps were taken in the review: (i) identification of the research question; (ii) definition of inclusion and exclusion criteria; (iii) literature search; (iv) selection of articles; (v) data extraction; (vi) risk of bias and quality assessment of studies; and (vii) analysis with both individual data and synthesis of findings, with a summary of evidence.

Research Question Identification

The central question of this study was: "Is there an association between excessive exposure to video games and impulsive behaviors?" This question was developed following the FINER criterion (Feasible, Interesting, New, Ethical, and Relevant). The guiding research question was feasible and ethical, as previous studies have established a link between impulsivity and other addictive behaviors. This criterion was proposed by Cummings et al. (1988) and has now been adopted in several systematic review protocols. The research question was also interesting and new, given the recent classification of G.D. as an addictive disorder. Furthermore, the question was relevant given that the systematization of research results can enhance our understanding of the potential risk factors and treatment for G.D.

Definition of Inclusion and Exclusion Criteria

We used the PECOS criteria to define the characteristics of the studies to be included (Morgan et al., 2018). Our Population included individuals who engaged in video gaming, including those with and without G.D. (Exposition), whom we Compared on impulsivity. Possible Outcomes included a positive association between impulsivity and G.D., with impulsivity being a predictor of G.D. across

different samples. Individuals of all ages were included in the "Population" and "Exposure" criteria. For Study design, we included cross-sectional, experimental, longitudinal and/or exploratory studies.

Only peer-reviewed manuscripts were included in the review. We did not include a date restriction. We included studies published in Portuguese, English, or Spanish. We excluded articles that did not fit the design (i.e., empirical studies), such as intervention studies, protocols, literature reviews (integrative, narrative, systematic), or qualitative studies. We also excluded studies with comorbid conditions that may have influenced the results. We also excluded studies on substance use and aggression that were not directly related to gaming.

Literature Search

The search was conducted in the *Biblioteca Virtual em Saúde* (BVS), Cumulative Index to Nursing and Allied Health Literature (CINAHL), PubMed, PsycNET, Scopus, and Web of Science databases, between January and April of 2021. The search terms used were identified in the Medical Subject Headings indexers (MeSH) and/or *Descritores em Ciências da Saúde* (DeCS, Health Sciences Descriptors) and were combined with Boolean operators to form the search strings in each database. The search terms for each database are shown in Table 1.

Selection of Articles

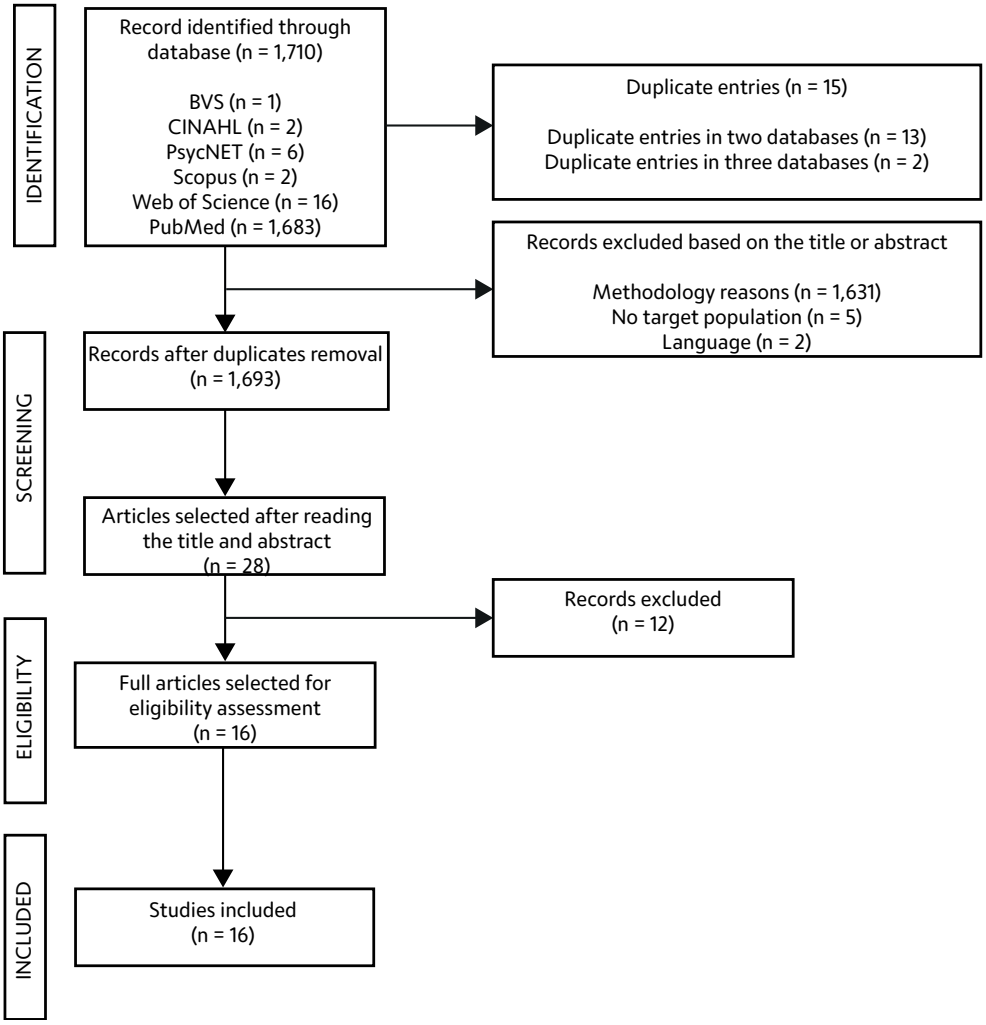
The studies retained from the searches (N = 1,710) were imported into Rayyan® software in RIS format (Ouzzani et al., 2016). After excluding duplicates (n = 17), two independent reviewers screened the articles according to the eligibility criteria. Each reviewer conducted a blind review. Discrepancies were resolved through discussion with the entire team (see Figure 1 for a PRISMA flow chart).

Table 1
Search strings for articles in the databases and the number of studies exported from each database

Database	Algorithm	Exported Studies
BVS	(Adolescent OR student OR adult) AND (impulsiv* OR disinhibition) not (aggression) AND (videogame OR video?game OR digital game OR game) AND (prospective OR longitudinal)	1
CINAHL	(Adolescent OR student OR adult) AND (impulsiv* OR disinhibition) NOT (aggression) AND (videogame OR video?game OR digital game OR game) AND (prospective OR longitudinal)	2
PsycNET	(Any Field: Adolescent OR Any Field: student OR Any Field: adult) AND (Any Field: impulsiv* OR Any Field: disinhibition) NOT (Any Field: aggression) AND (Any Field: videogame OR Any Field: video?game OR Any Field: digital game OR Any Field: game) AND (Any Field: prospective OR Any Field: longitudinal)	6
Scopus	((adolescent OR student OR adult) AND (impulsiv* OR disinhibition) AND (videogame OR video? game OR digital AND game OR game) AND (prospective OR longitudinal))	2
Web of Science	((Adolescent OR student OR adult) AND (impulsiv* OR disinhibition) NOT (aggression) AND (videogame OR video?game OR digital game OR game) AND (prospective OR longitudinal))	16
PubMed	(Adolescent OR student OR adult) AND (impulsiv* OR disinhibition) NOT (aggression) AND (videogame OR video?game OR digital game OR game) AND (prospective OR longitudinal)	1,683
Total		1,710

Note: BVS: *Biblioteca Virtual em Saúde*; CINAHL: Cumulative Index to Nursing and Allied Health Literature.

Figure 1
Information flow with the distinct phases of the systematic review



Data Extraction

After screening, potentially relevant studies (*n* = 28) were retrieved for full-text review by three independent experts (identified as A, B, and C, as shown in Figure 1). The study included 16 six articles for quantitative analysis and integrative synthesis.

Quantitative analysis (extraction, tabulation, and categorization of results) was conducted using Airtable software <https://www.airtable.com/>. Data were categorized according to (i) publication details (authors, year, country, sample profile, age, presence and length of follow-up, and presence of a control group); (ii) measurement instruments (scales, interviews, and other instruments to assess impulsivity, video game dependence, and other study variables); (iii) methodological design; (iv) conflicts of interest; and (v) main findings.

Assessing the Bias and Quality of Studies

We assessed the bias of studies using the ROBIS tool (Whiting et al., 2016), which consists of three steps: (i) assessing the studies' relevance; (ii) detecting concerns about the review process;

and (iii) judging the risk of bias. Regarding the second step, we used four dimensions to assess the risk of bias: (i) study eligibility criteria; (ii) identification and selection of studies; (iii) data collection and study appraisal; and (iv) synthesis and findings (Table 2).

Table 2
ROBIS checklist

Phase 1: Assessing Relevance		
Category	Target question (e.g. Overview or guideline)	Review being assessed
Patients/Population(s):	Individuals with gaming disorder	Is there an effect of overexposure to electronic games related to impulsive behavior?
Exposition(s):	Excessive use of electronic games	
Comparator(s):	Individuals without G.D. or impulsivity	
Outcome(s):	There is a positive association between impulsivity and G.D.; G.D is a predictor for impulsivity; no differences between different genders or countries regarding the association studied	
Phase 2: Identifying Concerns with the Review Process Legend: Y: Yes, PY: Probably yes, PN: Probably no, N: No, NI: No information		
Domain 1: Study Eligibility Criteria		
1.1 Did the review adhere to pre-defined objectives and eligibility criteria?		Y/PY/PN/N/NI
1.2 Were the eligibility criteria appropriate for the review question?		Y/PY/PN/N/NI
1.3 Were eligibility criteria unambiguous?		Y/PY/PN/N/NI
1.4 Were any restrictions in eligibility criteria based on study characteristics appropriate (e.g., date, sample size, study quality, outcomes measured)?		Y/PY/PN/N/NI
1.5 Were any restrictions in eligibility criteria based on sources of information appropriate (e.g., publication status or format, language, availability of data)?		Y/PY/PN/N/NI
Domain 2: Identification And Selection of Studies		
2.1 Did the search include an appropriate range of databases/electronic sources for published and unpublished reports?		Y/PY/PN/N/NI
2.2 Were methods additional to database searching used to identify relevant reports?		Y/PY/PN/N/NI
2.3 Were the terms and structure of the search strategy likely to retrieve as many eligible studies as possible?		Y/PY/PN/N/NI
2.4 Were restrictions based on date, publication format, or language appropriate?		Y/PY/PN/N/NI
2.5 Were efforts made to minimize error in selection of studies?		Y/PY/PN/N/NI
Domain 3: Data Collection and Study Appraisal		
3.1 Were efforts made to minimize error in data collection?		Y/PY/PN/N/NI
3.2 Were sufficient study characteristics available for both review authors and readers to be able to interpret the results?		Y/PY/PN/N/NI
3.3 Were all relevant study results collected for use in the synthesis?		Y/PY/PN/N/NI
3.4 Was risk of bias (or methodological quality) formally assessed using appropriate criteria?		Y/PY/PN/N/NI
3.5 Were efforts made to minimize error in risk of bias assessment?		Y/PY/PN/N/NI
Domain 4: Synthesis and Findings		
4.1 Did the synthesis include all studies that it should?		Y/PY/PN/N/NI
4.2 Were all pre-defined analyses reported or departures explained?		Y/PY/PN/N/NI
4.3 Was the synthesis appropriate given the nature and similarity in the research questions, study designs and outcomes across included studies?		Y/PY/PN/N/NI
4.4 Was between-study variation (heterogeneity) minimal or addressed in the synthesis?		Y/PY/PN/N/NI
4.5 Were the findings robust, e.g., as demonstrated through funnel plot or sensitivity analyses?		Y/PY/PN/N/NI
4.6 Were biases in primary studies minimal or addressed in the synthesis?		Y/PY/PN/N/NI

Table 2
ROBIS checklist

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Phase 3: Judging Risk of Bias (summarize the concerns identified during the phase 2 assessment)		
Domain	Concern	Rationale for concern
1. Concerns regarding specification of study eligibility criteria	Low	All information is in the report and considerable effort has been made to bring specificity to the research question and objectives, and the criteria for eligibility have been detailed and justified
2. Concerns regarding methods used to identify and/ or select studies	Low	All criteria for study identification were considered and added in this paper
3. Concerns regarding methods used to collect data and appraise studies	Low	We detailed all three domain criteria in the manuscript to reduce the risk of bias
4. Concerns regarding the synthesis and findings	Low	Based on the synthesis of the results, they demonstrate the intended association and, therefore, can be considered relevant findings, and the synthesis aimed to approach the theme broadly, with the main contributions
Risk of Bias in the Review		
Describe whether conclusions were supported by the evidence: Some studies had small sample sizes, and others had no control groups; there was difficulty in defining PIU (problematic internet use) in some papers.		
A. Did the interpretation of findings address all the concerns identified in Domains 1 to 4?		Y/PY/PN/N/NI
B. Was the relevance of identified studies to the review's research question appropriately considered?		Y/PY/PN/N/NI
C. Did the reviewers avoid emphasizing results based on their statistical significance?		Y/PY/PN/N/NI
Risk of bias in the review		Low/High/Unclear
Rationale for risk: We used six search databases and three independent judges, and one judge responsible for the Minerva Vote. The criteria used were developed based on Finer and the PICOS strategy. The evaluations were done autonomously, and disagreements were discussed in meetings.		

Results and Discussion

There were most studies conducted in Europe (56.2%), followed by Asia (43.7%). Almost 70.0% of the articles were published between 2011 and 2019. In this study, the sample size ranged from 18 to 3,658, and the participants were eight to 49 years old. There were eight cross-sectional studies (50.0%), and seven experimental studies (43.7%), five longitudinal studies (31.2%), and four exploratory studies (25.0%). A total of eight studies used multiple methodological designs. Table 3 presents the main methodological and measurement instrument characteristics of each study.

Regarding measurement instruments, eleven measures of impulsivity were used. The measures included self-report questionnaires, with 54.5% of instruments previously validated in the country of study. Five (31.25%) of 16 studies included a behavioral measure of impulsivity (Table 2). The behavioral tasks included: (i) the Cups Task, (ii) the Single Key Impulsivity Paradigm (SKIP), (iii) the Stop-Change Paradigm (or Stop-Signal task), and (iv) the Balloon Analogue Risk Task (BART). The most used scales were various versions of the Barratt Impulsiveness Scale (BIS) and the short and long versions of the Urgency, Premeditation, Perseverance, Sensation Seeking, and Positive Urgency (UPPS-P) Impulsive Behavior Scale. The BIS is is one of the most used instruments in the world to measure impulsivity (Kapitány-Fövény et al., 2020; Vasconcelos et al., 2012). The UPPS-P is a newer measure of impulsivity but has become more widely used in recent years.

Table 3

Each study's main methodological and instrumental characteristics are in alphabetical order (n = 16)

nº	Authors/ Year	Countries	Age	Method	Control Group	Arms (n)	Impulsivity Assessment	Videogame Addiction Assessment	Other Measures
1	Cerniglia, Griffiths et al. (2019)	Italy	14-19	Cs	No	EG = 643	BIS11-A	IGDS9-SF; BSMAS	SCL-90-R3
2	Cerniglia, Guicciardi et al. (2019)	Italy	14-19	Exs	No	EG = 656	BIS11-A	IGDS9-SF; BSMAS	SCL-90-R3
3	Gentile et al. (2011)	Singapore	8-17	Ls	No	EG = 3,034 G3 = 743 G4 = 711 G7 = 916 G8 = 664	BIS-11	GMHQ; Pathological video game use; Problematic gaming	Personal Strengths Inventory-II; Children's Empathic Attitudes Questionnaire; Self-report of aggression; ADHD screen; Asian adolescent depression scale
4	Gentile et al. (2012)	Singapore	8-17	Ls	No	EG = 3,034	BIS-11	Self-report (hours)	ADHD Symptoms Scale Self-Report; Self-report (school performance)
5	Irvine et al. (2013)	England	> 18	Es, Cs	Yes	EG = 26 CG = 26	UPPS Impulsive Behaviour Scale	GAS, 7-item version; YBOCS adapted for video games; frequency/ number of days played	Beck Depression Inventory-II; MINI; NART; IST; Delay Discounting Task; Premature responding task; SST
6	Lalot et al. (2017)	France, United States, United Kingdom, Ireland, Canada, Switzerland, Belgium, Australia, New Zealand	*M = 29.3	Ls	No	EG = 402(I) EG = 151(II)	UPPS Impulsive Behaviour Scale	Self-report (hours; km)	HEXACO 6-trait personality inventory; NFCS; RCI; NFC; GSE
7	Lee et al. (2018)	South Korea	21-26	Es, Cs	Yes	EG = 45 CG = 35	BIS11-A	IAT	DSM-IV Axis I disorders; Wechsler Adult Intelligence Scale; Beck Depression Inventory-II; Beck Anxiety Inventory; Wender Utah Rating Scale
8	Liau et al. (2015)	China	*M = 21.9	Es, Cs	Yes	EG = 41 CG = 27	The cups task	Weekly time; CIAS	Beck Anxiety Inventory; Beck Depression Inventory-II; FTND; AUDIT-C
9	Nuyens et al. (2016)	Belgium	18-24	Exs	No	EG = 36	Single Key Impulsivity Paradigm; s-UPPS-P Impulsive Behavior Scale; BIS-11	POGQ	–
10	Peeters et al. (2019)	Netherlands	*M = 13.3	Ls	No	EG = 1928(I) EG = 1420(II)	ADHD questionnaire	Internet Gaming Disorder Scale; Questionnaire on gaming behavior; Self-report (hours); frequency/ number of days played	Harter's Self Perception Profile of Adolescents; subscale "Close Friendships"; 5-item Satisfaction with Life Scale
11	Qi et al. (2015)	China	*M = 17.2	Es, Cs	Yes	EG = 23 CG = 24	BIS-11; fMRI-adapted version of the BART	YDQ for internet addiction; Self-report (hours); IAT	SPM

Table 3

Each study's main methodological and instrumental characteristics are in alphabetical order (n = 16)

nº	Authors/ Year	Countries	Age	Method	Control Group	Arms (n)	Impulsivity Assessment	Videogame Addiction Assessment	Other Measures
12	Qi et al. (2016)	China	*M = 17.1	Es	Yes	EG = 24 CG = 24	BIS-11; fMRI-adapted version of the BART	YDQ for internet addiction; IAT	SPM; SAS; SDS
13	Rho et al. (2018)	South Korea	20-49	Exs, Cs	No	EG = 3,658 (481 IGD/3087 normal)	DII; BSCS; BIS/ BAS	Query to DSM-V	SCL-90-R; AUDIT-K; FTND
14	Sariyska et al. (2017)	Germany	*M = 22.3	Es, Ls	Yes	EG(I) = 79 EG(II) = 44 EG(III) = 94	BIS-11; one item from SOEP	s-IAT; OGAS; Self-report (experience); WoW Specific Problematic Usage-Engagement Questionnaire	–
15	Steenbergen et al. (2015)	Netherlands, Germany	*M = 21.2	Es, Cs	Yes	EG = 18 CG = 18	Stop-Change paradigm	Self-report (experience)	SPM, MINI
16	Su et al. (2019)	Hungry	14-38	Exs, Cs	No	EG = 596	BIS-21	POGQ	Brief Symptom Inventory

Note: *There was no description of the age variation of the participants, choosing to use the mean, the only age measure offered in the study); –: Non-Declared on Article; (I): Baseline; (II) and (III): Follow-up; BART: Balloon Analogue Risk Task; BIS/BAS: Behavioral Inhibition System/Behavioral Activation System; BIS11: Barratt Impulsiveness Scale; BIS11-A: Barratt Impulsiveness Scale for Adolescents; BSCS: Brief Self-Control Scale; BSMAS: Bergen Social Media Addiction Scale; C.G.: Control Group; CIAS: Chinese Internet Addiction Scale; Cs: Cross-Sectional Study; DII: Dickman Impulsivity Inventory-Short Version; DSM-V: Diagnostic and Statistical Manual of Mental Disorders; Es: Experimental Study; Exs: Exploratory Study; G.E.: Experimental Group; G3: Class 3; G4: Class 4; G7: Class 7; G8: Class 8; GAS: Game Addiction Scale; GMHQ: General Media Habits Questionnaire; IAT: Internet Addiction Test; IGD: Internet Gaming Disorder; IGDS9-SF: Internet Gaming Disorder Scale-Short Form; Ls: Longitudinal Study; OGAS: Online Game Addiction Scale; POGQ: Problematic Online Gaming Questionnaire; s-IAT: Short Version of the Internet Addiction Test; SOEP: German Socio-Economic Panel; UPPS-P: Urgency, Premeditation, Perseverance, Sensation Seeking and Positive Urgency; WoW: World of Warcraft; YBOCS: Yale-Brown Obsessive Compulsive Scale; YDQ: Young's Diagnostic Questionnaire.

We identified 19 different measures of G.D., and only 26.3% of the instruments were validated in their respective countries. Using different methods and instruments to assess the same constructs or phenomena (such as G.D.) can lead to heterogeneity of outcomes (Lopes et al., 2015; Johnson et al., 2017), which may preclude the comparison of results between different studies on the same topic.

The main findings regarding the association between G.D. and impulsivity are described in Table 3. A total of 11 (68.75%) of 16 studies compared those with and without G.D. and reported a positive association between G.D. and impulsivity, providing support for our first hypothesis. Only one study (Steenbergen et al., 2015) focused on action games and did not identify impairments in inhibitory control. This data reinforces Mestre-Bach and colleagues' (2018) idea that G.D. needs to be further studied so that personalized intervention programs targeted to specific population characteristics are developed.

In a recent systematic review, Şalvarlı and Griffiths (2022) identified 33 studies, 32 of which reported a positive association between impulsivity and G.D. Moreover, they also noted that impulsivity is a predictor for G.D. This data is in line with our results, in which most authors found a positive association between impulsivity and G.D. An explanation of why Şalvarlı and Griffiths (2022) included more studies compared to our work may be due to the search algorithm used, which allowed us to retain some number of papers. Additionally, it is possible that the authors considered a more flexible diagnostic criterion for G.D. without necessarily having some formal measurement instrument. Furthermore, our study complements the work of Şalvarlı and Griffiths (2022), as the

authors included papers up to 2019 (the year of manuscript submission), whereas we included papers up to 2021. In addition, we included the data extraction method and ROBIS protocol to assess the manuscript quality and risk of bias (Table 4).

Considering each dimension of impulsivity, nine studies (56.2%) highlighted the presence of high-risk trends like sensation seeking or engaging in risky behaviors (Gentile et al., 2011; Gentile et al., 2012; Lee et al., 2018; Liau et al., 2015; Peeters et al., 2019; Qi et al., 2015; Qi et al., 2016; Rho et al., 2018; Sariyska et al., 2017), and two studies (12.5%) identified a high sensitivity for rewards (Lee et al., 2018; Qi et al., 2016). Four studies (25.0%) identified reduced inhibitory control (Irvine et al., 2013; Lee et al., 2018; Peeters et al., 2019; Qi et al., 2015), and six studies (37.5%) identified low self-control (Irvine et al., 2013; Lalot et al., 2017; Liau et al., 2015; Peeters et al., 2019; Rho et al., 2018; Su et al., 2019). Furthermore, four studies (25.0%) found cortical differences indicating higher rates of impulsivity (Lee et al., 2018; Liau et al., 2015; Qi et al., 2015; Qi et al., 2016).

Table 4

Main results found in the evaluated studies

nº	Authors	Main Results
1	Cerniglia, Griffiths et al. (2019)	Relation between technology-based addictions and impulsivity, with differences in the age and profile of adolescents, and not in gender
2	Cerniglia, Cuicciardi et al. (2019)	Impulsivity correlated with higher levels of G.D., indicating a risk factor for pathological (video) gaming. The identified associations may change, considering the stage of development and gender
3	Gentile et al. (2011)	Greater gaming reduced social competence, and greater impulsivity was a risk and maintenance factor for G.D. The prevalence of gaming was similar to other countries
4	Gentile et al. (2012)	Individuals who were more impulsive or had attention problems spent more time playing video games, suggesting bidirectional causality
5	Irvine et al. (2013)	G.D. was associated with impulsivity related to impaired decision-making, with negative consequences on task performance
6	Lalot et al. (2017)	The personality traits, perseverance, and forethought (sub-dimensions of impulsivity), positively predicted continuous gaming, as did the affability
7	Lee et al. (2018)	Differences in gray matter were observed among individuals with G.D. and changes in risk or reward decision-making and reduced behavioral control
8	Liau et al. (2015)	Neurobiological basis for decision-making deficits in individuals with G.D. and maintenance of persistence for gaming
9	Nuyens et al. (2016)	Presence of links between impulsivity-related constructs in MOBA games, from its pathological use
10	Peeters et al. (2019)	Lack of control associated with G.D. Adolescents with impulsivity and attention issues are more likely to be attracted to games and less likely to stop playing. G.D. was positively associated with impulsivity and hyperactivity only in boys
11	Qi et al. (2015)	There is greater impulsivity and less sensitivity to risk in adolescents with G.D. than in the control group regarding brain activation
12	Qi et al. (2016)	Covariance between risk level and brain activation was significantly greater in adolescents with G.D. compared to the control group. There was activation in value estimation, reward anticipation, and emotional learning focused on risk decision-making
13	Rho et al. (2018)	Eight risk factors were significantly associated with G.D., such as functional and dysfunctional impulsivity, belief in self-control, and money spent on video games
14	Sariyska et al. (2017)	High-risk trends were associated with G.D. among healthy individuals, suggesting the potential for risk decisions as a predictor of G.D. in a non-gaming population. Males had elevated high-risk trends, such as higher weekly gaming hours
15	Steenbergen et al. (2015)	Action games are associated with improved executive control processes and multi-component behavior without inhibitory control
16	Su et al. (2019)	Gender differences among online gamers mediate impulsivity, but not G.D. prevalence, and impatience partially mediates the relationship between psychiatric stress and G.D.

Note: G.D.: Gaming Disorder); MOBA: Multiplayer Online Battle Arena.

According to the research included in this review, randomized controlled trials have demonstrated a positive association between impulsivity and substance use disorders (Berey et al., 2019; Blevins et al., 2019; Yuan et al., 2020). Together, these studies support developing and improving treatment strategies for harmful behaviors involving impulsivity, such as substance use disorder, problematic internet use, and/or video games.

Five studies evaluated gender differences among players (Cerniglia, Griffiths et al., 2019; Cerniglia, Guicciard et al., 2019; Peeters et al., 2019; Sariyska et al., 2017; Su et al., 2019). Of these, four reported greater impulsivity among males (except for Cerniglia, Griffiths et al., 2019). This is consistent with literature identifying a higher prevalence of impulsive behavior among men (D'Éça Júnior et al., 2019; Scheffer & Almeida, 2010). In a study by Scheffer and Almeida (2010), the authors reported higher impulsivity and impulsive-aggressive health risk behaviors among men. Likewise, another study observed higher rates of suicide among men due to high competitiveness, impulsivity, and access to firearms and lethal weapons (D'Éça Júnior et al., 2019). Furthermore, a recent randomized controlled trial by Foltin et al. (2021) identified higher levels of impulsivity among males who use cocaine than females who use cocaine. When considering these findings, gender differences are worth examining in future studies of G.D.

It is important to acknowledge that our study has limitations: (i) studies in languages other than those previously described in the methods section were not included; (ii) we considered studies with different levels of evidence and methodological rigor, and our data may contain non-peer-reviewed studies, depending on the publication's profile; (iii) not all studies included information on whether the measurement instruments were valid and appropriate for their country.

Conclusion

In summary, we found that most studies were conducted in Europe and that sample characteristics varied widely between studies. Nevertheless, several studies identified strong associations between impulsivity and G.D. Among the main implications of this study, we detected a positive association between impulsivity and G.D., particularly in individuals with increased severity of G.D. This relationship is even more explicit among men than women, indicating the need to identify more gaming disorder-specific characteristics in men.

In addition to having clinical implications, our findings may assist in the identification and treatment of G.D., notably by reducing impulsive behavior, as well. By managing the primary triggers associated with impulsivity, individuals may also be able to decrease their time spent playing video games, which may result in reduced psychiatric comorbidities related to G.D. Furthermore, given that several aspects of impulsivity were related to G.D., a behavior that is common to substance use disorders and internet addiction, further research is needed to understand better the risks associated with this behavior so that prevention and treatment programs can be designed specifically tailored to this population.

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Contributors

A. L. M. ANDRADE, F. M. LOPES, and A. SCATENA drafted the manuscript. A. L. M. ANDRADE, F. B. H. LOBATO, and N. STANGE contributed to data acquisition. A. L. M. ANDRADE conducted the statistical analyses. A. L. M. ANDRADE, F. M. LOPES, and H. S. KIM were responsible for interpreting and discussing the results. All authors provided critical manuscript revisions to improve the intellectual content and approved the final version.