

## Review article

## Depressive symptoms and depression in individuals with internet gaming disorder: A systematic review and meta-analysis

Edoardo G. Ostinelli<sup>a,†</sup>, Caroline Zangani<sup>a,†</sup>, Barbara Giordano<sup>a</sup>, Davide Maestri<sup>a</sup>, Orsola Gambini<sup>a,b</sup>, Armando D'Agostino<sup>a,\*</sup>, Toshi A. Furukawa<sup>c</sup>, Marianna Purgato<sup>d,e</sup>

<sup>a</sup> Department of Health Sciences, University of Milan, Italy

<sup>b</sup> "Aldo Ravelli" Research Center for Neurotechnology and Experimental Brain Therapeutics, University of Milan, Italy

<sup>c</sup> Departments of Health Promotion and Human Behavior and of Clinical Epidemiology, Kyoto University Graduate School of Medicine/School of Public Health, Kyoto, Japan

<sup>d</sup> Department of Neurosciences, Biomedicine and Movement Sciences, University of Verona, Italy

<sup>e</sup> WHO Collaborating Centre for Research and Training in Mental Health and Service Evaluation, University of Verona, Italy

## ARTICLE INFO

## Keywords

Internet gaming disorder  
Addiction  
Depression  
IGD  
Depressive symptoms  
Behavioural addiction

## ABSTRACT

**Background:** Although depression has frequently been associated with Internet Gaming Disorder (IGD), its epidemiological impact on this emerging condition has not been systematically assessed. In this study, we aimed to synthesize the available evidence focusing on depression and depressive symptoms in individuals with IGD.

**Methods:** We searched PubMed, Embase, PsycINFO, GreyLit, OpenGrey, and ProQuest up to March 2020 for observational studies focusing on depression-related outcomes in IGD. We conducted random-effects meta-analyses on 1) rate of comorbid depression in IGD; 2) severity of depressive symptoms in IGD participants without depression.

**Results:** We identified 92 studies from 25 different countries including 15,148 participants. 21 studies (n = 5025 participants) provided data for the first analysis, resulting in a pooled event rate of depression of 0.32 (95% Confidence Interval 0.21–0.43). The pooled Beck Depression Inventory scores in individuals without depression were suggestive of mild severity (13 studies, n = 508; 10.3, 95% Confidence Interval 8.3–12.4).

**Limitations:** The considerable inconsistency of methods employed across studies limits the transferability of these findings to clinical practice.

**Conclusions:** The prevalence of depression in individuals with IGD varied considerably across studies, affecting approximately one out of three participants overall. Furthermore, a globally major severity of depressive symptoms was found in those without a clinical diagnosis of depression, compared to the general population. These findings confirm a relevant impact of mood disturbances in IGD.

**Registration detail:** PROSPERO (CRD42018100823).

## 1. Introduction

According to the American Psychiatry Association (APA), "Internet Gaming Disorder" (IGD) typically indicates a persistent and recurrent use of internet to engage in games, leading to clinically significant impairment or distress. Despite this, APA clarifies that IGD consists of both online and offline games (APA, 2013). While IGD is listed in the Section 3 of the Diagnostic and Statistical Manual of Mental Disorder (DSM) 5 as a "condition warranting more clinical research and experience" before including it as a formal disorder (APA, 2013), the World Health Organization (WHO) formally included it in the 11<sup>th</sup> Revision of the International Classification of Diseases (ICD-11) as "Gaming Disorder"

(WHO, 2018). The importance of this disorder is further highlighted by evidence reporting prevalence estimates between 0.7% and 27.5% in the general population, with youth at higher risk (Mihara and Higuchi, 2017).

Individuals with IGD may present comorbid psychiatric disorders, and depression is among the most frequently associated conditions (Carli et al., 2013; González-Bueso et al., 2018; Männikkö et al., 2017; Sussman et al., 2018). Recent studies suggested that IGD and depression have several symptoms in common, such as anhedonia, social withdrawal, poor work and school performances, fatigue, and disruption of sleep-wake patterns (Achab et al., 2011; Burke and Pepper, 2002). Moreover, IGD and depression may share biological and psychological substrates, with the

\* Corresponding author: Department of Health Sciences, San Paolo University Hospital, via Antonio di Rudini 8, 20142, Milan, Italy.

E-mail address: [armando.dagostino@unimi.it](mailto:armando.dagostino@unimi.it) (A. D'Agostino)

† Equal contribution

first facilitating the onset of the latter in predisposed subjects (Mikuska and Vazsonyi, 2017; van Rooij et al., 2018).

Despite these considerations, the overall impact of depression comorbidity and depressive symptoms on individuals with IGD is still unknown. An in-depth understanding on the baseline affective characteristics of people with IGD may contribute 1) to the development of diagnostic criteria; 2) to gain insight on the burden of depressive disorders in IGD, thereby contributing to develop tailored interventions and improve the level of care (Block, 2008; Vaccaro and Potenza; 2019).

Against this background, we conducted a systematic review and meta-analysis to collect available evidence on depression and depressive symptoms in people with IGD. Specifically, we aimed at: 1) estimating the comorbidity rate of depression in individuals with significant IGD symptoms, and exploring its variability; 2) assessing the severity of depressive symptoms in individuals with significant IGD symptoms without a diagnosis of depression.

## 2. Methods

The present systematic review was conducted following the recommendations of the MOOSE and PRISMA statements (Moher et al., 2009; Stroup et al., 2000) (Appendix S1). The protocol was registered on PROSPERO (CRD42018100823).

### 2.1. Search methods

A comprehensive systematic computer-based search was conducted to identify published and unpublished evidence for depression and IGD. We searched PubMed, Embase, PsycINFO, GreyLit, OpenGrey and ProQuest with keywords and thesauri relevant to IGD and depression (see Appendix S2 for the full search strategy). We inspected relevant reviews, expert consensus, and references of included studies as additional source of potentially eligible studies. A scoping search to address potential planning issues was conducted in February and May 2018. The systematic search was performed in March 2020. No language or time restrictions were applied.

### 2.2. Selection criteria

#### 2.2.1. Study types

We included case-control, cohort, and cross-sectional studies informing on depression in the IGD population. Sample selection of randomised controlled studies (RCT) is thought to suffer from low external validity, in particular when determinants of generalisability are not assessed and described. Their representativeness to the wider population may thus be limited (Kennedy-Martin et al., 2005; Rothwell, 2005).

*Prevalence of depression in individuals with significant IGD symptoms (Meta-analysis-1, MA-1)*

#### 2.2.2. Population

We included studies focusing on either adolescent (10–18 years old) or adult participants (18 years or older) (WHO, 2013), defined by study-specific age restrictions (e.g. study-specific inclusion criteria) or, secondarily, by age range of recruited participants or their mean age at baseline. To provide a reliable estimate of the prevalence of depression, we excluded studies where a diagnosis of depression was pre-specified as either inclusion or exclusion criteria.

#### 2.2.3. Condition

Studies were eligible if they satisfied the following criteria: 1) a focus on “gaming addiction”, “gaming disorder”, “pathologic gaming”, specifically intended as a voluntarily dysfunctional online or offline use of videogames (e.g. computer and console games), rather than online gambling addiction (e.g. betting websites), social media addiction (e.g. Facebook, Reddit) and compulsive online shopping (e.g. Amazon, Al-

ibaba). We excluded studies in which “excessive gaming” was defined solely by the number of playing hours (e.g. “screen time”) (Király et al., 2015); 2) authors provided a definition of criteria for IGD (e.g. criteria, validated assessment scale, clinical evaluation in a secondary or tertiary care setting). Given that a definition of gaming addiction is currently debated (Király et al., 2015), we borrowed the “IGD” nomenclature from the DSM-5 (APA, 2013). Specifically, we use “individuals with significant IGD symptoms” to refer to individuals experiencing a significant impairment from online/offline gaming misuse.

#### 2.2.4. Outcome

We investigated the prevalence of depressive disorders in individuals with significant IGD symptoms, defined as population proportion, mean proportion per study and pooled prevalence (see the ‘statistical analysis’ section).

*Depressive symptoms in individuals with significant IGD symptoms (Meta-analysis-2, MA-2)*

#### 2.2.5. Population

We included studies focusing on either adolescent (10–18 years old) or adult participants (18 years or older) (WHO, 2013), defined by study-specific age restrictions (e.g. study-specific inclusion criteria) or, secondarily, by age range of recruited participants or their mean age at baseline.

To avoid over-estimation of depressive symptoms, we only included data from participants without a diagnosis of depression (i.e. studies that listed depression as an exclusion criterion or that provided estimates for the non-depressed population sub-group).

#### 2.2.6. Condition

We used the same criteria defined above for MA-1.

#### 2.2.7. Outcome

Levels of depressive symptoms in individuals with significant IGD symptoms, measured by validated scales, either self- or interviewer administered.

### 2.3. Selection of studies, data extraction

At least two investigators independently screened titles and abstracts of identified records and reviewed the full text of potentially eligible studies. Any discrepancies were resolved by consensus with a third member of the review team. Non-English papers were assessed by individuals proficient in that language or with the help of a translator. Where needed, we contacted original authors to further clarify the eligibility assessment. A list of excluded studies and reasons for exclusions is provided as supplemental material (Appendix S3). Duplicated and multiple publications were merged. Two review authors independently extracted study characteristics, outcome data, and any relevant details using a digital data extraction form.

Authors of potentially eligible studies that failed to provide details for study eligibility were contacted through multiple attempts (Appendix S4). When no further information was available, we labeled these studies as “awaiting assessment”.

Studies that identified individuals with significant IGD symptoms as a sub-group from a broader sample without providing sub-group data were included, although they could not contribute to quantitative analyses. An attempt to retrieve data from the original investigator was made.

### 2.4. Quality assessment

Quality of included studies was assessed with the Newcastle-Ottawa Scale (NOS) for non-randomised studies (Modesti et al., 2016; Wells et al.,

2020). The NOS is composed by 8 questions (7 for cross-sectional studies) assessing how the study population is selected; the comparability between compared groups (e.g., cases and controls in a study); whether the outcome/exposure is assessed in a reliable manner. The quality of the outcomes was assessed with the Joanna Briggs Institute (JBI) critical appraisal tool (Munn et al., 2015). The JBI is a nine-item checklist evaluating sample selection, setting, and statistical analyses appropriateness at an outcome level. As no standardized criteria or thresholds to interpret this quality outcome are available, we agreed on the following thresholds: six out of nine items rated as positive were considered indicative of “high” quality, four to five of “moderate” quality, and zero to three of “low” quality. Studies in which four or more items could not be assessed were overall rated as “unclear”.

### 2.5. Statistical analysis

For dichotomous data, a random-effects meta-analysis of the event rate of depression in individuals with significant IGD symptoms was calculated. For continuous data, we performed a random-effects meta-analysis of mean depressive symptoms scores.

Consistency between studies was measured with I2 statistics, following the Cochrane Handbook thresholds for the interpretation (Deeks et al., 2011). As pre-specified in the protocol, we attempted to explore high levels of inconsistency by taking into account some study-level variables (e.g. single versus multi-center, country, game genre, setting, study design). We acknowledged that sub-group analyses pose several problems with interpretation (Deeks et al., 2011), thus we focused on the heterogeneity levels rather than making assumptions on the sub-group effect sizes. The statistical analyses were performed using Stata (STATA Corp, 2015).

### 3. Results

We identified 3347 citations, from which 2997 were removed after duplicates check and abstract screening (Fig. 1). After screening potentially relevant full-text articles, 92 unique studies were identified from 118 records (Table 1). 66 authors were contacted with a 43.9% response rate. Of these, 20 researchers supplied the requested information (Appendix S4).

Included studies were classified as follows: 52 cross-sectional, 30 case-control, and 10 prospective cohort. The videogame genre was only reported in 15 studies (16.3%) with Massively Multiplayer Online (MMO) games being the most frequently reported (10 studies). Asian countries (45 studies) accounted for almost half of the included studies, while the remaining were either from Europe (31 studies), North America (6 studies), Oceania (6 studies), Africa (2 study), or across different regions (2 studies). Four out of five of the identified studies were rated at least 5 stars at NOS quality assessment (Appendix S5).

Overall, IGD symptoms were assessed by scales (48 studies, 52.2%), means of diagnostic criteria (30 studies, 32.6%), a combination of the previous two (7 studies, 7.6%) or clinical evaluations (7 studies, 7.6%). Several studies required functional impairment or screen time as additional criteria. The eligibility criteria was most frequently assessed using DSM-5 criteria (33 studies), followed by the Internet Addiction Test (IAT, 10 studies) (APA, 2013; Young, 1998).

#### 3.1. Prevalence of depression in individuals with significant IGD symptoms (MA-1)

21 studies (n = 5025 participants) were included in the quantitative analyses: 5 studies were classified as case-control, 13 studies as cross-sectional, with the remaining (three studies) as cohort (Appendix S6). Included studies were conducted in Asia (9 studies), Europe (7

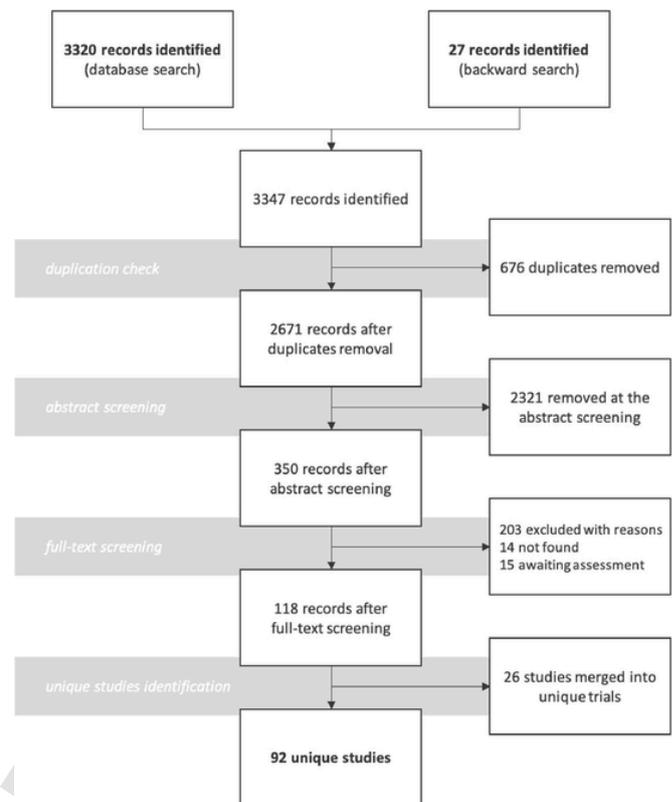


Fig. 1. Flowchart of identified records.

studies), North America (2 studies), Oceania (1 study), Africa (1 study) or in countries across different geographical areas (1 study).

In four studies, gender (female) was an exclusion criterion, while in one study this detail was unclear. In studies without gender-related criteria, data on male/female ratio was available for 11 out of 16 studies (n = 2711 participants) with female participants accounting for 27.4% of the recruited population. Overall, 10 studies reported the mean age of participants, resulting in a weighted mean age of 24.1 years.

The pooled event rate of depression comorbidity in individuals with significant IGD symptoms was of 0.32 (95% CI 0.21–0.43; I2 = 98.40%), ranging from 0% to 75% (Fig. 2). center (i.e. single vs multi), country, setting and study design only partially explained the considerable level of inconsistency across studies (Appendix S7).

According to JBI, the quality was rated as “high” in the majority of studies (71.4%), “moderate” in 9.5%, “low” in 4.8%, and “unclear” in the 14.3% of the studies.

#### 3.2. Depressive symptoms in individuals with significant IGD symptoms (MA-2)

22 studies (n = 770 participants) provided data on depressive symptoms (Appendix S6). The majority were conducted in Asia (20 studies, 90.9%). Pooled mean age of participants was of 22.2 years, and 97.1% of them were males. Overall, 20 individuals (2.7%) were reported to have a comorbid disorder (ADHD, n = 14; gambling, n = 6).

Of the included studies with available data, 13 assessed depressive symptoms with Beck's Depression Inventory (BDI) (Beck et al., 1961) and were included in meta-analysis. Age and gender distribution were comparable to the pool of studies informing on this outcome (97.8% males, weighted mean age of 22.0 years). The pooled BDI score in individuals with significant IGD symptoms without a diagnosis of depression (n = 508 participants) was 10.31 (95% CI 8.3–12.4; I2 = 97.3%) (Fig. 3). Again, centres (i.e. single vs multi), country, setting and study de-

**Table 1**

Studies included in the review.

Legend: IAT = Internet gaming test; GAS = Gaming addiction scale (-SF = short form); CIAS = Children internet addiction scale; PVP = Problem Video Game Playing Questionnaire; CGAI = Computer Gaming Addiction Invention; PTU = Pathological Technology use; POGQ = Problematic online gaming questionnaire (-SF = short form); AICA = Assessment of Internet and Computer game Addiction (-C = checklist, -S = scale); SCI-IGD = Structured Clinical Interview for DSM-5 Internet Gaming Disorder; IGD-T-10 = Internet Gaming Disorder Test 10 items; IGDS-SF = Internet Gaming Disorder scale short form; PVGT = problem videogame playing test; IADQ = Internet addiction diagnostic questionnaire; PIE-9 = Personal internet gaming Disorder Evaluation-9 items; BAM-VG = Behavioral addiction measure for video gaming; MINI = Mini-International Neuropsychiatric Interview; VGUQ = Video Game Use Questionnaire; ISS-20 = Problematic internet use scale; GAIT = Gaming Addiction Identification Test; RPG = Role-Playing Game; WoW = World of Warcraft; MMO = Massively Multiplayer Online; MMORPG = Massively Multiplayer Online Role-Playing Game; FPS = First Person Shooter; RTS = Real Time Strategy; MOBA = Multiplayer Online Battle Arena; US = United States.

The complete list of included studies is available as Appendix 8.

Author	Year	Type	IGD definition	Game details	country
Ahmadi et al.	2014	cross-sectional	clinical judgment	.	Iran
Bae et al.	2017	case-control	IAT; DSM-5	.	South Korea
Bargeron and Hormes	2017	cross-sectional	DSM-5	.	US
Bonnaire and Baptista	2019	cross-sectional	GAS	RPG, simulation/strategy, action, adventure	France
Chérif et al.	2014	cross-sectional	IAT; Fisher's criteria	.	Tunisia
Choi et al.	2017	case-control	DSM-5	League of Legend, FIFA, Sudden Attack	South Korea
Choo et al.	2010	cohort - prospective	Questionnaire based on DSM (10 items)	.	Singapore
Deleuze et al.	2017	case-control	Questionnaire based on DSM (10 items)	.	Belgium
Deng et al.	2017	cohort - prospective	CIAS	.	China
Dong et al.	2012	case-control	IAT	.	China
Dong et al.	2018	case-control	IAT; DSM-5	League of Legends	China
Du et al.	2017	case-control	IAT; IADQ	.	China
Ford	2016	cross-sectional	DSM-5	WoW	Canada
Gaetan et al.	2014	cross-sectional	GAS	.	France
Gaetan et al.	2015	cross-sectional	GAS	.	France
Gonzalvez et al.	2017	cross-sectional	PVP	.	Spain
Han et al.	2010	case-control	IAT	Star Craft	South Korea
Han et al.	2018	cohort - prospective	IAT	MMORPG, FPS, RTS, other	South Korea
Han et al.	2020	cohort - prospective	DSM-5	.	South Korea
Huang et al.	2010a	case-control	CGAI	.	China
Huang et al.	2010b	case-control	adapted criteria from Young and Ko et al.	.	China
Jeong et al.	2019	case-control	DSM-5	.	South Korea
Jiménez-Murcia et al.	2014	cross-sectional	Videogame dependency test	.	Spain
Jo et al.	2019	cohort - prospective	DSM-5	.	South Korea
Kang et al.	2018	case-control	clinical judgment	.	South Korea
Kaplan et al.	2014	cross-sectional	POGQ	.	US
Kaptsis et al.	2016	cohort - prospective	IGD criteria checklist	MMO	Australia
Khazaal et al.	2016	cross-sectional	GAS	.	Switzerland

Author	Year	Type	IGD definition	Game details	country
Kim et al.	2015	case-control	DSM-5	.	South Korea
Kim et al.	2017a	cross-sectional	DSM-5	.	South Korea
Kim et al.	2017b	case-control	IAT; DSM-5	.	South Korea
Kim et al.	2016	case-control	DSM-5	.	South Korea
King et al.	2018	case-control	DSM-5	.	Australia
King et al.	2013	cross-sectional	PTU; PVGT	.	Australia
Király et al.	2014	cross-sectional	POGQ	.	Hungary
Király et al.	2019	cross-sectional	IGDT-10	.	Hungary
Koo et al.	2017	cross-sectional	SCI-IGD	.	South Korea
Krossbakken et al.	2018	cross-sectional	GAS	.	Norway
Kwak et al.	2020	case-control	DSM-5	.	South Korea
Laconi et al.	2017	cross-sectional	DSM-5	.	France
Laconi et al.	2015	cross-sectional	IAT; GAS	.	France
Lau et al.	2019	cross-sectional	DSM-5	.	China
Lee et al.	2014	case-control	clinical judgment	.	South Korea
Lee et al.	2017	cohort - prospective	DSM-5	.	South Korea
Lee et al.	2018a	cohort - prospective	DSM-5	.	South Korea
Lee et al.	2018b	case-control	IAT; DSM-5	.	South Korea
Lee et al.	2019	case-control	DSM-5	.	South Korea
Lehenbauer-Baum et al.	2015	cross-sectional	WoW-questionnaire	WoW	Germany
Lemenager et al.	2018	case-control	AICA-C; AICA-S	.	Germany
Lim et al.	2016	cohort - prospective	DSM-5	.	South Korea
Liu et al.	2013	case-control	IAT; Diagnostic Questionnaire for Internet Addiction criteria by Beard	.	China
Liu et al.	2016	case-control	Diagnostic Questionnaire for Internet Addiction criteria by Beard	.	China
Liu et al.	2018	case-control	CIAS	.	China
Lorenz et al.	2012	case-control	Grüsser & Thalemann criteria	MMORPG	Germany
Mallorquí-Bagué et al.	2017	cross-sectional	DSM-5	.	Spain
Marchica et al.	2020	cross-sectional	IGDS-SF	.	Canada
Maroney et al.	2018	cross-sectional	PVGT	MMORPG, FPS	North and South America, Europe, Africa, Australasia
Mentzoni et al.	2011	cross-sectional	GAS	MMORPG	Norway
Metcalfe and Pammer	2011	case-control	Addiction-engagement questionnaire	MMORPG	Australia
Mihara et al.	2019	cross-sectional	clinical judgment	.	Japan
Mukesh et al.	2019	cross-sectional	GAS	.	India
Müller et al.	2019	cross-sectional	clinical judgment	.	Germany

Author	Year	Type	IGD definition	Game details	country
Müller et al.	2010	cross-sectional	AICA	.	Germany
Myrseth et al.	2017	cross-sectional	GAS	.	Norway
Na et al.	2017	cross-sectional	DSM-5	.	South Korea
Paik et al.	2017	cross-sectional	DSM-5	Genre according to Korean Games White Paper	South Korea
Park et al.	2017	case-control	DSM-5	.	South Korea
Pearcy et al.	2017	cross-sectional	PIE-9	.	Australia
Phan et al.	2019	cross-sectional	clinical judgment	.	France
Reer et al.	2020	cross-sectional	IGDS-SF	.	Germany
Ryu et al.	2018	case-control	DSM-5	.	South Korea
Sanders et al.	2018	cross-sectional	BAM-VG	MMORPG, MOBA, various	Canada
Scherer et al.	2019	cross-sectional	AICA	.	Germany
Schmit et al.	2011	cross-sectional	MINI	.	France
Sebeyran et al.	2011	cross-sectional	IADQ	.	France
Seong et al.	2019	case-control	DSM-5	.	South Korea
Shi et al.	2020	cross-sectional	IGDS	.	China
Singh et al.	2019	cross-sectional	IGDS-SF	Simulation or strategy games, RPG, sport or racing games, shooting or action games, board games	India
Son et al.	2014	case-control	clinical judgment	.	South Korea
Sosso et al.	2020	cross-sectional	GAS-SF	.	Africa
Starcevic et al.	2010	cross-sectional	VGUQ	.	Australia
Stetina et al.	2011	cross-sectional	ISS-20	MMORPG, FPS, RTS	Germany
Stockdale and Coyne	2018	cross-sectional	DSM-5	.	US
Strittmatter et al.	2015	cross-sectional	IADQ	.	Estonia, Germany, Romania, Spain
Taechoyotin et al.	2020	cross-sectional	IGD-20 Test	.	Thailand
Tang et al.	2018	cross-sectional	POGQ-SF	.	Singapore, Hong Kong/Macao, China, South Korea, Taiwan, Japan, US
Vadlin et al.	2016	cross-sectional	GAIT	.	Sweden
Wartberg et al.	2017	cross-sectional	IGDS	.	Germany
Wartberg et al.	2020	cross-sectional	IGDS-SF	.	Germany
Wölfling et al.	2014	cohort - prospective	AICA-Scale $\geq 7$ ; AICA-Checklist $\geq 13$	.	Germany
Wu et al.	2018	cross-sectional	DSM-5	.	Macao
Yeh et al.	2017	case-control	DSM-5	.	China

sign sub-group analyses could only partially account for such considerable level of inconsistency in the study estimates (Appendix S7). The quality of studies contributing to the meta-analysis was rated as “high” (4.5%), “moderate” (68.2%), “low” (22.7%) or “unclear” (4.5%) according to JBI.

Other rating scales adopted across studies were BDI-II (18.22, 95% CI 9.13–27.31; I2 = 99.5%; 4 studies) (Appendix S7) (Beck et al., 1996),

Symptom Checklist-90-R (SCL-90-R) depression (2 studies; mean and summed scores of items not pooled) (Derogatis, 1992), BDI-13 items (1 study) (Beck and Beck, 1972), Children's Depression Inventory (CDI) (1 study) (Kovacs, 1985) and Self-rating Depression Scale (SDS) (1 study) (Zung, 1965). Please refer to Appendix S6 for study-specific details on scales employed.

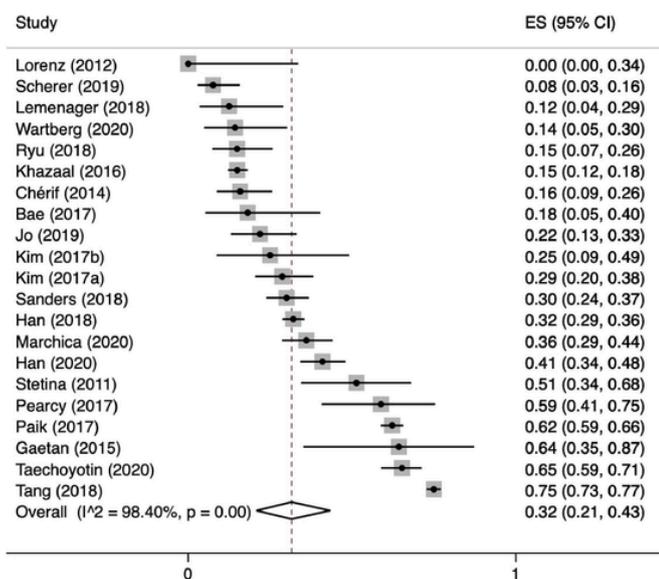


Fig. 2. Forest plot on the pooled depression comorbidity event rate in individuals with significant Internet Gaming Disorder symptoms. Legend: “ES” = Effect Size; “CI” = Confidence Interval.

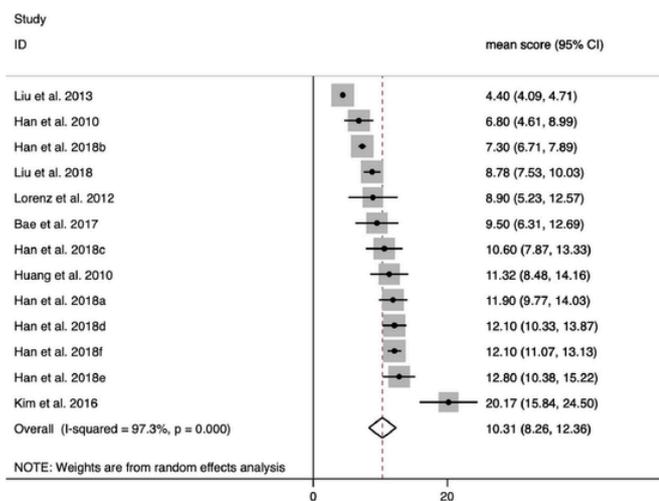


Fig. 3. Forest plot on the pooled Beck's Depression Inventory mean scores. Legend: “CI” = Confidence Interval. 0–9: minimal depression; 10–18: mild depression; 19–29: moderate depression; > 29: severe depression (Beck et al., 1988).

#### 4. Discussion

This systematic review and meta-analysis aimed to synthesize the current state of research on depression in individuals with significant IGD symptoms. We identified 92 unique studies conducted in 25 different countries including 15,148 participants. The reported comorbidity of depression in included individuals ranged from 0% to 75%, with a pooled prevalence of 32%. Among the participants without a formal diagnosis of depression, affective symptoms were suggestive of sub-threshold depression. The most used rating scale to assess intensity of depression was the BDI scale (Beck et al., 1961), previously used in individuals with several psychiatric and medical conditions, as well as in the general population (Smarr and Keefer, 2011). According to Beck and colleagues (1988) a score of 10 differentiates between minimal and clinically significant depression of mild intensity.

About two-thirds of the investigated studies were conducted in Asian countries, with South Korea contributing for over a fourth of the identified reports. More than a decade ago the South Korean govern-

ment defined IGD as one of its most serious public health issues (Ahn, 2007) after having to struggle with a series of cardiopulmonary deaths related to gaming addiction (Choi, 2007; Koh, 2007). In 2011 the controversial “shutdown law” or “Cinderella law” went into effect, forbidding children under the age of sixteen to play online videogames between midnight and early morning. Exemption of console and mobile gaming, economic interests, and freedom limitation led to a dispute that resulted in an amendment in 2014, allowing parents to request their children to be legally exempted from restriction. Similar laws have been either proposed or adopted in other countries, like China, Thailand and Vietnam.

Our result on the prevalence of depression is consistent with the concerns on the importance of comorbidities in the IGD population (Block, 2008; González-Bueso et al., 2018). The considerable variability identified strengthens the need to further analyze the relationship between IGD and depression (van Rooij et al., 2018; Aarseth et al., 2017). The comorbidity of depression, as well as other disorders, may affect both diagnosis and outcomes of IGD, contributing to the reported treatment resistance (Block, 2007). On the other hand, the overlap between some characteristics of both IGD and depression (Achab et al., 2011; Burke and Pepper, 2002; Guillot et al., 2016; Király et al., 2014; Li and Wong, 2015; Sublette and Mullan, 2012) may result in diagnostic uncertainty, either lowering or increasing the rate of depression diagnosis. Indeed, our findings suggest that individuals with significant IGD symptoms may face depressive symptoms during the course of illness even in the absence of an established comorbidity, ranging from levels comparable to the general population to depressive symptoms of moderate severity (Wahl et al., 2014). Particularly, the reported mean values were below or comparable to those of the general population in six studies, and comparable to mild or moderate depression categories in eight and three studies respectively (Wahl et al., 2014).

The following limitations should be considered when interpreting findings from this review. First, although studies were mostly rated as moderate-to-high quality according to the NOS, they failed to report several details related to IGD. For instance, studies jointly focused on “videogames” as a whole, with less than one quarter of the studies providing further details (e.g. game genre classification). Failure to characterize game exposure and to differentiate different profiles of the included population might delay understanding of this condition, potentially inflating the heterogeneity between studies (Block, 2008; Király et al., 2015). This might have contributed to the considerable levels of between-study inconsistency in our analyses, together with other factors, such as the different IGD definitions employed (King and Delfabbro, 2014; Petry and O'Brien, 2013). Second, not all of the included studies could contribute to the quantitative analysis, as many studies failed to report relevant details. To overcome this issue, we searched several databases for secondary publications and contacted the majority of the original investigators with an author response rate of 44%.

This systematic review and meta-analysis highlights the need for high-quality studies investigating the role of depression in people with significant IGD symptoms. Future longitudinal studies should aim to define the socio-demographic and clinical characteristics of individuals with IGD, and the trajectories of psychological symptoms over time, as well as to identify those individuals at higher risk of developing depressive symptoms. This would inform implementation strategies to provide at-risk individuals with appropriate evidence-based interventions, according to a public mental health approach.

#### Author contribution

EGO and CZ conceived and designed the study. CZ, DM, BG and EGO selected the articles and extracted the data. CZ, DM and BG contacted the original investigators. MP and EGO analyzed the data. TAF provided supervision of the research group. CZ and EGO wrote the first draft of the manuscript. MP, TAF, ADA, and OG carefully revised the

manuscript several times and added some sections. All authors agreed with the results and conclusions of this article.

## Fundings

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## Declaration of Competing Interest

OG reports lecture fees from Chiesi. TAF reports personal fees from Meiji, Mitsubishi-Tanabe, MSD and Pfizer and a grant from Mitsubishi-Tanabe, outside the submitted work; TAF has a patent 2018–177,688 pending. All other authors declare no competing interests.

## Acknowledgements

The authors would like to thank the original investigators that provided additional information, data or details (listed in alphabetical order): Chérif L, Choi IY, Dong G, Khazaa Y, Kim DJ, King DL, Király O, Koo HJ, Krossbakken E, Kwon JH, Lee D, Lemenager T, Liu J, Metcalf O, Müller K, Park SM, Sanders J, Scherer L, Stockdale L, Vadlin S, Wartberg L.

The data that supports the findings of this study are available in the supplementary material of this article.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jad.2021.02.014.

## References

- Aarseth, E., Bean, A.M., Boonen, H., Colder Carras, M., Coulson, M., Das, D., van Rooij, A.J., et al., 2017. Scholars' open debate paper on the World Health Organization ICD-11 gaming disorder proposal. *J. Behav. Addict.* 6, 267–270. doi:10.1556/2006.5.2016.088.
- Achab, S., Nicolier, M., Mauny, F., Monnin, J., Trojak, B., Vandell, P., Haffen, E., et al., 2011. Massively multiplayer online role-playing games: comparing characteristics of addict vs non-addict online recruited gamers in a French adult population. *BMC Psychiatry* 11, 144. doi:10.1186/1471-244X-11-144.
- Ahn, D.H., 2007. Korean policy on treatment and rehabilitation for adolescents' Internet addiction. In: 2007 International Symposium on the Counseling and Treatment of Youth Internet Addiction. National Youth Commission, Seoul, Korea, p. 49.
- American Psychiatric Association (APA), 2013. Section III: emerging Measures and models. American Psychiatric Association (APA). *Diagnostic and Statistical Manual of Mental Disorders*, 5th ed. American Psychiatric Publishing, Arlington, pp. 795–798.
- Beck, A.T., Beck, R.W., 1972. Screening depressed patients in family practice. A rapid technique. *Postgrad. Med.* 52, 81–85.
- Beck, A.T., Steer, R.A., Garbin, M.G.J., 1988. Psychometric properties of the beck depression inventory twenty-five years of evaluation. *Clin. Psychol. Rev.* 8, 77–100. doi:10.1016/0272-7358(88)90050-5.
- Beck, A.T., Ward, C.H., Mendelson, M., 1961. An inventory for measuring depression. *Arch. Gen. Psychiatry* 4, 561–571.
- Beck, A.T., Steer, R.A., Brown, G.K., 1996. BDI-II: Beck Depression Inventory Manual. 2nd ed. Psychological Corporation, San Antonio.
- Block, J.J., 2007. Lessons from Columbine: virtual and real rage. *Am. J. Forensic Psychiatry*. 28, 5–33.
- Block, J.J., 2008. Issues for DSM-V: internet addiction. *Am. J. Psychiatry*. 165, 306–307. doi:10.1176/appi.app.2007.07101556.
- Burke, A., Pepper, E., 2002. Cumulative trauma disorder risk for children using computer products: results of a pilot investigation with a student convenience sample. *Public Health Rep.* 117, 350–357. doi:10.1016/S0033-3549(04)50171-1.
- Carli, V., Durkee, T., Wasserman, D., Hadlaczky, G., Despalins, R., Kramarz, E., Kaess, M., 2013. The association between pathological internet use and comorbid psychopathology: a systematic review. *Psychopathology* 46, 1–13. doi:10.1159/000337971.
- Choi, Y.H., 2007. Advancement of IT and seriousness of youth Internet addiction. In: 2007 International Symposium on the Counseling and Treatment of Youth Internet Addiction. National Youth Commission, Seoul, Korea, p. 20.
- Deeks, J.J., Higgins, J.P.T., Altman, D.G., 2011. Chapter 9: analysing data and undertaking meta-analyses, in: Higgins, J. P. T., Green, S., editors. *Cochrane Handbook for Systematic Reviews of Interventions* Version 5.1.0 (updated March 2011). The Cochrane Collaboration 2011. Available at [www.handbook.cochrane.org](http://www.handbook.cochrane.org).
- Derogatis, L.R., 1992. SCL-90-R: administration, Scoring of Procedures manual-II For the R (revised) Version and Other Instruments of the Psychopathology Rating Scale Series. clinical psychometric research incorporated.
- 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. *Int. J. Environ. Res. Public Health*. 15, 668. doi:10.3390/ijerph15040668.
- Guillot, C.R., Bello, M.S., Tsai, J.Y., Huh, J., Leventhal, A.M., 2016. Sussman, S. Longitudinal associations between anhedonia and internet-related addictive behaviors in emerging adults. *Comput. Human. Behav.* 62, 475–479. doi:10.1016/j.chb.2016.04.019.
- Kennedy-Martin, T., Curtis, S., Faries, D., Robinson, S., Johnston, J., 2005. A literature review on the representativeness of randomized controlled trial samples and implication for the external validity of trial results. *Trials* 16, 495. doi:10.1186/s13063-015-1023-4.
- King, D.L., Delfabbro, P.H., 2014. Internet gaming disorder treatment: a review of definitions of diagnosis and treatment outcome. *J. Clin. Psychol.* 70, 942–955. doi:10.1002/jclp.22097.
- Király, O., Griffiths, M.D., Demetrovics, Z., 2015. Internet Gaming Disorder and the DSM-5: conceptualization, debates, and controversies. *Curr. Addict. Rep.* 2, 254–262. doi:10.1007/s40429-015-0066-7.
- Király, O., Naggyörgy, K., Griffiths, M.D., Demetrovics, Z., Rosenberg, K., Feder, L., 2014. Problematic online gaming. Behavioral addictions: criteria, Evidence and Treatment, editors Elsevier, New York, pp. 61–95.
- Koh, Y.S., 2007. Development and application of K-Scale as diagnostic scale for Korean internet addiction. In: 2007 International Symposium on the Counseling and Treatment of Youth Internet Addiction. Seoul, Korea, 294. National Youth Commission.
- Kovacs, M., 1985. The children's depression inventory (CDI). *Psychopharmacol. Bull.* 21, 995–998.
- Li, T.M.H., Wong, P.W.C., 2015. Youth social withdrawal behavior (hikikomori): a systematic review of qualitative and quantitative studies. *Aust. N. Z. J. Psychiatry*. 49, 595–609. doi:10.1177/0004867415581179.
- Männikkö, N., Ruotsalainen, H., Miettinen, J., Pontes, H.M., Kärräinen, M., 2017. Problematic gaming behaviour and health-related outcomes: a systematic review and meta-analysis. *J. Health Psychol.* doi:10.1177/1359105317740414.
- Mihara, S., Higuchi, S., 2017. Cross-sectional and longitudinal epidemiological studies of Internet Gaming Disorder: a systematic review of the literature. *Psych. Clin. Neurosci.* 71, 425–444. doi:10.1111/pcn.12532.
- Mikuska, J., Vazsonyi, A.T., 2017. Developmental links between gaming and depressive symptoms. *J. Res. Adolesc.* 28, 680–697. doi:10.1111/jora.12359.
- Modesti, P.A., Reboldi, G., Cappucco, F.P., Agyemang, C., Remuzzi, G., Rapi, S., et al., 2016. Panethnic differences in blood pressure in Europe: a systematic review and meta-analysis. *PLoS ONE* 11, e0147601. doi:10.1371/journal.pone.0147601.
- Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G., 2009. The PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med* 6, e1000097. doi:10.1371/journal.pmed.1000097.
- Munn, Z., Moola, S., Lisy, K., Riitano, D., Tufanaru, C., 2015. Methodological guidance for systematic reviews of observational epidemiological studies reporting prevalence and incidence data. *Int. J. Evid. Based. Healthc.* 13, 147–153. doi:10.1097/XEB.0000000000000054.
- Petry, N.M., O'Brien, C.P., 2013. Internet Gaming Disorder and the DSM-5. *Addiction* 108, 1186–1187. doi:10.1111/add.12162.
- Rothwell, P.M., 2005. External validity of randomised controlled trials: "to whom do the results of this apply? *Lancet* 365, 82–93. doi:10.1016/S0140-6736(04)17670-8.
- Smarr, K.L., Keefer, A.L., 2011. Measures of depression and depressive symptoms: beck Depression Inventory-II (BDI-II), Center for Epidemiologic Studies Depression Scale (CES-D), Geriatric Depression Scale (GDS), Hospital Anxiety and Depression Scale (HADS), and Patient Health Questionnaire-9 (PHQ-9). *Psychol. Meas.* 63 S454-S466 doi:10.1002/acr.20556.
- StataCorp., 2015. *Stata Statistical Software: Release 14*. College Station, TX: StataCorp LP.
- Stroup, D.F., Berlin, J.A., Morton, S.C., Olkin, I., Williamson, G.D., Rennie, D., et al., 2000. Meta-analysis of observational studies in epidemiology: a proposal for reporting. *JAMA* 283, 2008–2012. doi:10.1001/jama.283.15.2008.
- Sublette, V., Mullan, B., 2012. Consequences of Play: a systematic review of the effects of online gaming. *Int. J. Ment. Health. Addiction.* 10, 3–23. doi:10.1007/s11469-010-9304-3.
- Sussman, C.J., Harper, J.M., Stahl, J.L., Weigle, P., 2018. Internet and video game addictions: diagnosis, epidemiology, and neurobiology. *Child. Adolesc. Psychiatr. Clin. N. Am.* 27, 307–326. doi:10.1016/j.chc.2017.11.015.
- Vaccaro, A.G., Potenza, M.N., 2019. Diagnostic and classification considerations regarding gaming disorder: neurocognitive and neurobiological features. *Front. Psychiatry* 10, 405. doi:10.3389/fpsy.2019.00405.
- van Rooij, A.J., Ferguson, C.J., Colder Carras, M., Kardefelt-Winther, D., Shi, D., Aarseth, E., Przybylski, A.K., et al., 2018. A weak scientific basis for gaming disorder: let us err on the side of caution. *J. Behav. Addict.* 7, 1–9. doi:10.1556/2006.7.2018.19.
- Wahl, I., Löwe, B., Björner, J.B., Fischer, F., Langs, G., Voderholzer, U., Aita, S.A., Bergemann, N., Brähler, E., Rose, M., 2014. Standardization of depression measurement: a common metric was developed for 11 self-report depression measures. *J. Clin. Epidemiol.* 67 (1), 73–86. doi:10.1016/j.jclinepi.2013.04.019.
- Wells, G.A., Shea, B., O'Connell, D., Peterson, J., Welch, V., Losos, M., et al., 2020. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. [http://www.ohri.ca/programs/clinical\\_epidemiology/oxford.asp](http://www.ohri.ca/programs/clinical_epidemiology/oxford.asp) (accessed 18 May 2020).
- World Health Organization (WHO), 2018. Gaming disorder. <http://www.who.int/features/qa/gaming-disorder/en/> (accessed 18 May 2020).
- World Health Organization (WHO), 2013. Definition of key terms. <https://www.who.int/hiv/pub/guidelines/arv2013/intro/keyterms/en/> (accessed 18 May 2020).
- Young, K.S., 1998. Internet addiction: the emergence of a new clinical disorder. *Cyber. Psychol. Behav.* 1, 237–244. doi:10.1089/cpb.1998.1.237.
- Zung, W., 1965. Self-Rating Depression Scale. *Arch Gen Psychiatry* 12, 63–70.