

Short Review

# Association Between Internet Gaming Disorder And Attention Deficit Hyperactivity Disorder: A Narrative Review

Hanin Bumozah<sup>1\*</sup> and Donna Alabdulbaqi<sup>2</sup>

<sup>1</sup>Resident of the Saudi Board Preventive Medicine, Ministry of Health, Eastern Province, Saudi Arabia

<sup>2</sup>MBBS, MSc, PhD, College of Health Sciences, Saudi Electronic University, Saudi Arabia

## Abstract

**Background:** The rapid increase in the popularity of internet use and video games is associated with multiple consequences and comorbidities; therefore, investigating this issue is important, especially now that the number of people playing video games has reached approximately 2.2 billion people worldwide.

**Method:** This paper reviews the existing literature on Google Scholar and PubMed to examine the association between internet gaming disorder (IGD) and attention deficit hyperactivity disorder (ADHD) between 2013 and 2020.

**Result:** The reviewed studies reveal a statistically significant association between ADHD and IGD. The reviewed studies demonstrate that ADHD is a predictive factor for the development and persistence of IGD and affects the severity of IGD symptoms.

**Conclusion:** Especially among those with ADHD, IGD causes life distress and social life impairment. This review indicates a statistically significant association between ADHD and IGD; however, longitudinal studies are needed to assist the direction of this association and make relevant and appropriate recommendations to prevent its consequences and comorbidities.

Gaming attracts many people worldwide. The number of people playing video games has reached approximately 2.2 billion people worldwide [1]. Based on the motivational approach we can classify gamers into four main categories. The achievers those who are playing to achieve goals such as high scores or new power, The explorers who play to explore new things such as new story, The socializer who play to make a social relationship with other such as by chat, and killers who play to follow gamer and annoy them [2].

The *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)* reported that the age group most vulnerable to internet gaming disorder (IGD) is adolescents, especially those between 12 and 20 years old. A recent study found that video game play can persist in those in the age group between 18 and 29 years old [3].

Research related to the etiology of the development of IGD is still in its infancy; however, existing research has suggested several factors are associated with its development. Some factors are related to gaming itself, such as the gaming motive

and structural game characteristics. Other factors are related to the gamer, such as psychological characteristics [4]. Some studies have indicated an association between IGD and certain mental health impairments occurring in adolescence, such as depression, anxiety, and hyperactivity [4]. However, it is still unclear whether these are the causes or consequences of IGD [4].

One of the comorbidities associated with IGD is attention deficit hyperactivity disorder (ADHD)/attention deficit disorder (ADD). In 2018, a comprehensive review that analyzed eight studies reported a significant correlation between IGD and ADHD and hyperactivity symptoms [5]. Another study on 3,000 children in elementary and secondary schools in Singapore measured IGD-like symptoms over two years. Although the study concluded that the risk factors for developing IGD are unclear, it indicated that those with high symptoms of IGD exhibit a higher likelihood of poor relationships with their parents over time, decreased academic performance, aggression tendencies, and depression [6]. In

## More Information

### \*Address for Correspondence:

Dr. Hanin Bumozah, Resident of the Saudi Board Preventive Medicine, Ministry of Health, Eastern Province, Saudi Arabia,  
Email: mafhj159@hotmail.com

**Submitted:** November 19, 2022

**Approved:** November 30, 2022

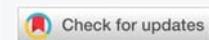
**Published:** December 01, 2022

**How to cite this article:** Bumozah H, Alabdulbaqi D. Association Between Internet Gaming Disorder And Attention Deficit Hyperactivity Disorder: A Narrative Review. *J Community Med Health Solut.* 2022; 3: 069-075.

**DOI:** 10.29328/journal.jcmhs.1001023

**Copyright License:** © 2022 Bumozah H, et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

**Keywords:** Deficient hyperactive disorder; ADHD; IGD; Internet gaming disorder





contrast, some studies have reported that video gaming may have a beneficial influence on cognitive training for ADHD [7].

### Internet gaming disorder and gaming disorder

The American Psychiatric Association (APA) published the *Diagnostic and Statistical Manual of Mental Disorders (DSM-5)* in 2013. Mental health professionals and researchers use this manual to diagnose mental disorders [8]. Moreover, *DSM-5* includes substance-related addictive disorders, such as alcohol, stimulants, and other addictions. However, gaming disorder is the only mentioned behavioral disorder [8].

Additionally, *DSM-5* notes that gaming must “cause significant impairment or distress in several aspects of a person’s life,” which is addressed in Section III in the fifth edition [8,9]. Moreover, *DSM-5* proposed criteria to diagnose IGD. A person must experience five or more of the symptoms mentioned below within one year to be diagnosed with the disorder [8,9]. The diagnosis is considered whether the person is using an electronic device or internet gaming [8,9]. The symptoms include preoccupation with gaming, withdrawal symptoms when gaming is impossible, tolerance – the need to spend more time gaming to satisfy the urge, inability to reduce playing, giving up other activities and loss of interest in previously enjoyed activities, continuing to play games despite problems, deceiving family members or others regarding the amount of time spent on gaming, the use of gaming to relieve negative moods, and risk – having jeopardized or lost a job or relationship due to gaming.

In 2018, the World Health Organization (WHO) published the 11th revision of the International Classification of Diseases (ICD-11) and classified gaming disorder as a disorder due to its ability to be an addictive behavior [10]. Therefore, gaming disorder is recognized by the WHO as a disorder. Hence, like any other disorder, it must be evaluated by public health authorities to initiate strategies and special programs to treat those affected and reduce its influence.

- Gaming disorder is considered a disorder because it is “a pattern of persistent or recurrent gaming behavior (‘digital gaming’ or ‘video-gaming’), which may be online (i.e., over the Internet) or offline.” The following criteria must be present for a diagnosis: Impairment of self-control over gaming, such as intensity, duration, frequency, and onset.
- Giving gaming priority over other daily activities and
- Continuing or increasing gaming even with the negative effects on daily life.

In addition to these criteria, significant impairment in various life aspects, such as personal, family, social, educational, occupational, or other factors, should be present. Nevertheless, for a diagnosis to be made, the symptoms should persist for 12 months. However, if the symptoms are

severe, a diagnosis can still be made if the symptoms persist for a shorter period [11].

There is complexity in describing IGD. For example, the APA refers to it as “Internet gaming disorder” and “Internet use disorder, Internet addiction, or gaming addiction” [10]. This review focuses on IGD rather than the other terms because of the presence of a standardized and validated assessment instrument [11]. Based on the diagnostic criteria the APA published in 2013, three questionnaires can assess IGD: the Internet Gaming Disorder Test-10 (IGDT-10), Internet Gaming Disorder Scale (IGDS) and Gaming Addiction Identification (GAIT); [5].

### Prevalence of internet gaming disorder

Based on a systematic review published in 2018, the prevalence rate of IGD varies based on the study and country, which could be related to the measurement tool or study population. The prevalence ranged between 0.6% in Norway and 50% in Korea [9]. Korea reported the highest prevalence rate in Eastern Asian countries, especially in male adolescents 12 to 20 years old. The median prevalence rate calculated in this study is 5.5% [9,10]. Interestingly, a recent systematic review published in 2020 stated that no studies report the prevalence of gaming disorder; however, 35 different methods were used to measure the prevalence of IGD [11]. The most common methods were the general application of *DSM-5* criteria, a health professional’s application of *DSM-5* criteria, and the IGDS Short Form-9 [11].

The prevalence of IGD according to the 61 studies included in the systematic review was 0.21% to 57.50% in the general population, and it ranged from 3.20% to 91.00% in the clinical population based on 10 studies. Six studies reported that the prevalence of IGD ranges from 50.42% to 79.25% for severe cases [11]. Regarding gender, a large study in the United States (US) found that male children are diagnosed with IGD up to five times more often than females [9]. The development of IGD may be related to many factors, such as mental health problems, social problems, or poor time management [9].

### Attention deficit hyperactivity disorder

IGD is often associated with ADHD [12]. According to a study that explored the association between IGD or pathological video game use and comorbid psychopathology, an 85% significant correlation exists between IGD and the symptoms of ADHD [5]. In addition, ADHD is a neurodevelopmental disorder [13], affecting 11% of school-age children. It is usually diagnosed in childhood, during school years [7], influencing behavior, education, and social life. It is characterized by a change in the levels of attention, impulsivity (rapid response without thinking) and hyperactivity [14]. The general population may be affected by ADHD by as much as 2.5% to 5% [13,15]. Based on the *DSM-5*, many symptoms should be present before age 12 [14]. A child must have at least six symptoms of the disorder



to be diagnosed as ADHD child compared with those 17 years or older who must have no fewer than five symptoms. These symptoms should persist not less than six months in two different settings such as home and school [16].

According to the *DSM-5* list, three presentations of ADHD exist: predominantly inattentive in this type of patient should have an inattentive criterion for the past 6 months, but not hyperactive/impulse criterion. The opposite will be considered as Hyperactive-impulsive within the same period [16]. The third type is the combined type in which both inattentive and hyperactive/impulsive criteria present for the past 6 months [16]. Each presentation has specific symptoms [14]. In addition, ADHD varies in severity from mild to severe [14].

Inattentive type the diagnostic Criteria are displayed poor listening skills, loss and/or misplacing of items needed to complete activities or tasks, being sidetracked by external or unimportant stimuli, forgetting daily activities, diminished attention span, lack of ability to complete schoolwork and other assignments or to follow instructions, avoids or is disinclined to begin homework or activities requiring concentration, fails to focus on details and/or makes thoughtless mistakes in schoolwork or assignments [16]. Hyperactive type includes these symptoms squirms when seated or fidgets with feet/hands, marked restlessness that is difficult to control, appears to be driven by “a motor” or is often “on the go”, lack of ability to play and engage in leisure activities in a quiet manner, incapable of staying seated in class, overly talkative. Moreover Impulsive symptoms are difficulty waiting turns. Interrupts or intrudes into conversations and activities of others, impulsively blurts out answers before questions are completed [16].

Children who have ADHD may be exposed to different kinds of problems, such as failure or delay in educational life, substance abuse, risky sexual behavior, and poor family and peer relationships [7,14]. About 50% to 80% of cases with ADHD complain of this disorder even in adolescence; however, hyperactivity may decrease with age [14]. In adulthood, they may complain of depression [14].

Multiple studies have investigated the cause of ADHD. Some scientists have detected a strong genetic association with ADHD, running in families [14]. It is an inherited disorder resulting from the interaction of multiple genes [14]. In addition, other environmental factors increase the likelihood of ADHD, such as exposure to lead or pesticides in early childhood, premature birth or low birth weight, and brain injury [14]. Other factors may worsen the course of ADHD, such as watching too much television, eating sugar, and having family problems [14].

### **What exposes an attention deficit hyperactivity disorder patient to internet gaming disorder?**

Some studies have reported that biopsychosocial

mechanisms could explain what makes a patient with ADHD vulnerable to internet addiction in general [17]. The counteractive effect of internet characteristics on ADHD symptoms, such as the quick response and immediate reward characterized by the internet, appear to counter two main symptoms of ADHD: “being easily bored” and “having an aversion for delayed reward” [17,18]. In addition, patients with ADHD have impaired inhibition, rendering them unable to control their internet behavioral addiction [17,18]. Moreover, the anonymity of internet gaming can replace the interpersonal relationship problem between patients with ADHD and the real world [17].

Hyperfocus “is a phenomenon that reflects one’s complete absorption in a task, to a point where a person appears to completely ignore or ‘tune out everything else” [19]. It is most often mentioned in the context of ADHD, autism, and schizophrenia but it is not mentioned as a clinical criterion of ADHD only observed in clinical work. Usually, patients with ADHD experience this phenomenon more than healthy people, especially in an interesting and unusual tasks for them such as video games [19]. However, the presence of this trait in children with ADHD confuses their parents such as when their kids play video games and ignore everything around them even with the presence of highly distractible symptoms in ADHD patients [19]. Although adults with ADD can experience this phenomenon. Some authors consider video games as a suitable environment to induce a hyperfocus state [19].

Gaming behavior must be monitored because of its influence on the gamer, which is not limited to converting to a gaming disorder. Such behavior also affects diet, daily activity, visual equity, musculoskeletal conditions, hearing, social function, sleep disturbance, depression, and aggressive behavior [20]. A study has reported that playing video games is associated with increased attention problems, especially in childhood [21]. Moreover, IGD has multiple consequences affecting various life aspects, such as academic and professional performance, which may appear in the form of low grades or even failure and sometimes financial problems, which could affect confidence and self-esteem [9]. Moreover, pathological gaming can also affect psychological aspects, causing gamers to develop sadness or suicidal ideation [9]. The physical health aspect may also be affected by an increased body mass index, hand-arm vibration syndrome, neck and elbow pain, and other problems related to the body position and reduced physical activity [9].

### **Aim**

All mentioned consequences make IGD an important public health issue. This paper reviews the existing studies that have explored the association between IGD and ADHD to make recommendations regarding whether screening programs and strategic planning are needed to decrease and prevent the negative effects of IGD on gamers and protect their psychosocial lives.

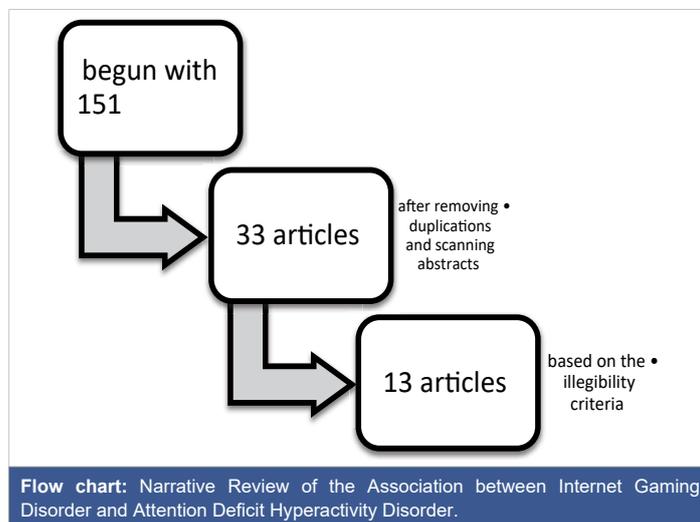
## Methodology

### Internet gaming disorder is a new concept

A comprehensive search for relevant studies published between January 1, 2013, and April 1, 2021, was conducted to achieve the aim of this review. The study is limited to this period because IGD is a new concept recently recognized as a disorder by the WHO in 2018 [10]. The search was conducted through Google Scholar and PubMed databases and was restricted to the type of study search based on the English language.

The search passed through three stages. The first stage was a primary screening based on an electronic search of the above databases. The following terms were used: (attention deficit hyperactive disorder OR ADHD) AND (internet gaming disorder OR electronic device OR gaming disorder\*) AND (incidence OR prevalence OR association\*). The second stage involved reviewing the article title, abstract, and assessment of the full-text manuscripts also the quality of evidence was assessed based on (GRADE) framework criteria. Finally, the results were summarized based on the studies that met the eligibility criteria. The included studies varied between cohorts, case controls, and systematic reviews, but most were cross-sectional studies without restriction to age group.

### Flow chart



## Results

Eleven studies met the illegibility criteria. A summary of these studies is presented in Table 1.

### Attention deficit hyperactivity disorder: a predictive factor for internet gaming disorder

A few studies have reported that ADHD is a predictive factor for developing IGD, as indicated in nine of the reviewed articles. A study conducted in the United Arab Emirates (UAE) reported that both types of ADHD (impulsivity and

inattention) have a statistically significant association with IGD as a predictor factor. Studies have found that the presence of IGD is explained or predicted by impulsivity more than inattention ( $R^2 = .159$  and  $R^2 = .128$ ) respectively; [1].

In contrast, after a regression analysis, another study reported that the association between a gaming disorder and inattention and hyperactivity has significant results only with inattention [15]. Another study reported the adjusted relative risk of those with ADHD to develop IGD (RR: 2.53, 95% CI (1.36, 4.69)) and ADHD was the highest risk factor for developing IGD compared with depression, playing for more than 240 minutes per weekday and playing multiplayer online games [15]. However, a higher level of hyperactivity or inattention increases the risk of developing IGD within one year [4]. Another study suggested that adults who have ADHD are more likely to develop IGD compared with those without ADHD (OR = 13.51, 95% CI (4.49, 0.64);  $p < .001$ ; [27].

According to a study published in 2016, those with IGD were 1.27 times more likely to complain of hyperactivity or inattention than those without IGD [29]. Another study stated that ADHD and depression symptoms in adolescents increase the probability of problematic gaming by 2.4 times [28]. One of the studies was conducted on 4- to 12-year-olds and reported that the highest addiction score in this age group was in the ADHD group compared with the clinical control and community groups [22].

### Attention deficit hyperactivity disorder is a consequence of internet gaming disorder

A study was conducted on 5,067 Swiss men to examine the association between IGD and ADHD by following the sample at different ages: 20, 21, and 25 years old, and each age group is called a wave [15]. The results were reported in two forms: cross-sectional association and longitudinal association. Based on the longitudinal association, the statistically significant results revealed the gaming disorder at Wave 1 (age 20) increased the likelihood to develop ADHD at Wave 3 [age 25] with an odds ratio [OR] of 1.47, and vice versa with an OR of 1.72 [15]. In addition, a study published in 2016 discussed the association between IGD and ADHD in adults between 20 and 35 years old in 87 individuals with IGD and 87 individuals without IGD [27]. The study reported an association between impulsivity and hostility in the IGD group and that the group with IGD had a higher score of impulsivity and hostility than the control group [27].

### Attention deficit hyperactivity disorder and the persistence of internet gaming disorder

Only one study reported that the persistence of IGD is associated with ADHD. The study revealed an adjusted relative risk equal to (aRRs: 2.14, 95% CI (1.01, 4.55)). Hence, the participants with ADHD had 2.14 times the risk of persistent high-risk IGD compared with those without ADHD [15].



**Table 1:** Summary of Included Studies.

Reference	Type of Study	Sample size	Main relevant results	Quality of evidence
[22]	Cross-sectional	80 participants: mean 4 - 12 years old	Analysis of variance and post hoc analyses revealed a statistically significant association between video gaming and prolonged playtime in the ADHD group. The highest addiction score was in the ADHD group compared to the other group.	Low
[1]	Cross-sectional	214 gamers from the United Arab Emirates; 18 - 33 years old	Impulsivity and inattention are vhighly associated with the increased likelihood of engagement in behaviors indicative of IGD.	Low
[23]	Longitudinal, using repeated clinical interviews	702 Norwegian participants; 10, 12, and 14 years old	No association exists between IGD and psychopathology except when IGD symptoms increase in these age groups. It is associated with reduced anxiety symptoms. The occurrence of these two issues is attributed to underlying risk factors.	Moderate
[24]	Prospective cohort study with 2-year follow study	2319 South Korean participants in 3 <sup>rd</sup> , 4 <sup>th</sup> , and 7 <sup>th</sup> grade	Risk factors of incidence of high risk for IGD (HIGD) include ADHD symptoms with adjusted relative risks (aRRs) of 2.53 ( $p < .05$ ). Predictors of persistence of HIGD were ADHD symptoms (aRRs = 2.14, $p < .05$ ).	Moderate
[25]	Cross-sectional	1509 volunteer university students in Ankara	ADHD is associated with IGD symptom severity, depression, and aggression, particularly physical aggression, anger, and hostility dimensions of aggression in the analyses of covariance.	Low
[4]	Cross-lagged panel design	T1: female = 593, male = 556,	A higher hyperactivity or inattention level is a predictive factor for developing IGD after one year.	Low
		T2: female = 486, male = 499; mean adolescent age 12.99 years at T1 and 13.89 years at T2		
[26]	Cross-sectional	164 Australian (mean age 23.0) 457 US-North Americans (mean age 25.25)	The US sample reported more ADHD symptoms than the Australian sample for inattention and hyperactivity-impulsivity. Both hyperactivity and inattention are associated with a higher IGD risk among emergent adults and massively multiplayer online gamers, independent of the country of origin.	Low
[5]	Comprehensive Review	21 cross-sectional and three prospective designs; most research was in Europe	The study reviewed eight studies after 2010. The majority were cross-sectional (five), two were case controls, and only one was longitudinal. A full association between IGD and ADHD and hyperactivity symptoms was reported in seven studies. One found no association.	Moderate
[15]	Longitudinal study	5,067 Swiss men (mean age 20 at Wave 1 and 25 at Wave 3)	Both gaming disorder and ADHD have a significant bidirectional longitudinal association. Participants with a gaming disorder at Wave 1 were more likely to exhibit ADHD at Wave 3 and vice versa. A gaming disorder at Wave 1 was more likely to persist to Wave 3 for participants with ADHD. However, a gaming disorder at Wave 1 was associated with new onsets of ADHD in a wave (OR = 1.63). ADHD was not more persistent in Wave 3 in participants with gaming disorder and ADHD at Wave 1 (OR = 0.92).	Moderate
[27]	Cross-sectional diagnostic interview	87 individuals with IGD and 87 controls without a history of IGD	A significant association exists between IGD and adult ADHD (OR = 13.51, 95% CI[4.49, 40.64]). The severity of IGD increased in young adults with both ADHD and IGD. Impulsivity and hostility also mediated the association between ADHD and IGD.	Low
[28]	Cross-sectional design	Community sample 1868 adolescents (1034 girls) 12–16 years old	No significant sex difference exists in ADHD symptoms. In the community sample, problematic gamers had more psychiatric symptoms than nonproblematic gamers ( $Z = -5.561, p = .001$ ). In the community sample, 21.3% of problematic gamers had symptoms of ADHD vs. 42.3% in the clinical sample ( $p = .019$ ), and 21.3% vs. 61.5% had depressive symptoms ( $p = .001$ ). Adolescents with ADHD and depression symptoms had 2.4 times the probability of problematic gaming. Those with ADHD and depressive symptoms had a lower degree of problematic gaming than those with ADHD symptoms but no depressive symptoms.	Low
		Clinical sample Consecutive sample of 242 adolescents (169 girls) 12–18 years old. Adolescents from Västmanland, Sweden, and their parents were included in a prospective cohort study (SALVe cohort).		
[29]	Cross-sectional design	1095 family dyads (adolescent 12–14 years old and a related parent)	No statistically significant associations exist between IGD and the (male) gender of the adolescent and hyperactivity or inattention.	Low
[30]	Cross-sectional survey	23,533 Norwegian participants; a mean of 35.8 years old	The regression analysis of ADHD, OCD, anxiety, and depression explains 6.6% of the variance in addictive video game use ( $R^2 = .066$ ). The standardized regression coefficient of ADHD ( $\beta = 0.176$ ) was positively associated with video game addiction.	Low



## Attention deficit hyperactivity disorder and the severity of internet gaming disorder

According to some studies, the severity of IGD symptoms increases with ADHD, such as a study conducted in Norway on 702 children and adolescents. The study reported that the increase in the severity of IGD is associated with an increase in the symptoms of ADHD [ $r = .23, p = .028$ ; [23]. A cross-sectional online survey in Ankara on 1,509 male and female university students indicated that 987 of the participants played video games and were assessed for IGD [25]. The statistically significant results based on an analysis of covariance revealed that ADHD, aggression (including physical), anger, hostility, and depression are all probable predictors of IGD symptom severity [25]. Finally, one of the studies stated that the combined group with ADHD and IGD had a higher severity of IGD and a higher score of impulsivity and hostility [27].

## Conclusion

This review reviewed 13 published articles related to the association between ADHD and IGD. Most articles reported cross-sectional studies, whereas only three were longitudinal and one was a comprehensive review. The studies were conducted in different countries, with only one study conducted in the Middle East, in UAE. The tools to assess IGD varied between studies, such as the IGDS-9, Internet Gaming Disorder Interview, Internet Game Use-Elicited Symptom Screen, gaming addiction scale, and GAIT, but most used IGDS-9. Regarding the ADHD assessment tools, most studies used the adult ADHD self-reported scale.

In conclusion, the reviewed studies demonstrate that ADHD is a predictive factor for the development and persistence of IGD and affects the IGD symptom severity. This association between ADHD and IGD could be bidirectional or one-sided, which requires more research, especially longitudinal studies. However, both ADHD and IGD negatively influence an individual's life because these disorders affect mental health, school and work performance, and life satisfaction.

## Limitations

Most studies are cross-sectional, which does not the exact direction of the association between both variables. In addition, the presence of different concepts for the same issue makes the search more difficult and could lead to unintentionally excluding some studies during the database search. Moreover, different IGD assessment tools may affect the result accuracy and make it difficult to compare studies. The only study in a Middle Eastern country was in UAE, and finally, most studies were performed at ages over 10 years old.

## Recommendations

Good strategies and screening programs are needed for IGD, especially for patients with ADHD. However, more research is still needed to fill in the knowledge gaps for this issue.

## Statement of ethics

The study is exempt from ethics committee approval because it is based on a review of previously published literature.

## Disclosures and Acknowledgment

We would like to thank the peer reviewers for their valuable comments and suggestion, and everybody help us to finish this paper.

## References

- Vally Z. Symptoms of Internet Gaming Disorder, Inattention, and Impulsivity: a Cross-Sectional Study Conducted in the United Arab Emirates. *Psychiatr Q.* 2021 Mar;92(1):301-310. doi: 10.1007/s11126-020-09799-2. PMID: 32642820.
- Naskar S, Victor R, Nath K, Sengupta C. One level more: A narrative review on internet gaming disorder. *Ind Psychiatry J.* 2016 cited 2022 Nov 29;25(2):145. Available from: /pmc/articles/PMC5479086/
- Stavropoulos V, Baynes KL, O'Farrel DL, Gomez R, Mueller A, Yucel M, Griffiths M. Inattention and Disordered Gaming: Does Culture Matter? *Psychiatr Q.* 2020 Jun;91(2):333-348. doi: 10.1007/s11126-019-09702-8. PMID: 31900821.
- Wartberg L, Kriston L, Ziegelmeier M, Lincoln T, Kammerl R. A longitudinal study on psychosocial causes and consequences of Internet gaming disorder in adolescence. *Psychol Med.* 2019 Jan;49(2):287-294. doi: 10.1017/S003329171800082X. Epub 2018 Apr 6. PMID: 29622057.
- González-Bueso V, Santamaría JJ, Fernández D, Merino L, Montero E, Ribas J. Association between Internet Gaming Disorder or Pathological Video-Game Use and Comorbid Psychopathology: A Comprehensive Review. *Int J Environ Res Public Health.* 2018 Apr 3;15(4):668. doi: 10.3390/ijerph15040668. PMID: 29614059; PMCID: PMC5923710.
- Gentile DA, Bailey K, Bavelier D, Brockmyer JF, Cash H, Coyne SM, Doan A, Grant DS, Green CS, Griffiths M, Markle T, Petry NM, Prot S, Rae CD, Rehbein F, Rich M, Sullivan D, Woolley E, Young K. Internet Gaming Disorder in Children and Adolescents. *Pediatrics.* 2017 Nov;140(Suppl 2):S81-S85. doi: 10.1542/peds.2016-1758H. PMID: 29093038.
- Strahler Rivero T, Herrera Nuñez LM, Uehara Pires E, Amodeo Bueno OF. ADHD Rehabilitation through Video Gaming: A Systematic Review Using PRISMA Guidelines of the Current Findings and the Associated Risk of Bias. *Front Psychiatry.* 2015 Oct 22;6:151. doi: 10.3389/fpsy.2015.00151. Erratum in: *Front Psychiatry.* 2016 Oct 17;7:173. PMID: 26557098; PMCID: PMC4614280.
- Cabot A, Pindell N. Regulating Internet Gaming. June 2018.
- Paulus FW, Ohmann S, von Gontard A, Popow C. Internet gaming disorder in children and adolescents: a systematic review. *Dev Med Child Neurol.* 2018 Jul;60(7):645-659. doi: 10.1111/dmcn.13754. Epub 2018 Apr 6. PMID: 29633243.
- Bickham DS. Current Research and Viewpoints on Internet Addiction in Adolescents. *Curr Pediatr Rep.* 2021;9(1):1-10. doi: 10.1007/s40124-020-00236-3. Epub 2021 Jan 9. PMID: 33457108; PMCID: PMC7796811.
- Darvesh N, Radhakrishnan A, Lachance CC, Nincic V, Sharpe JP, Ghassemi M, Straus SE, Tricco AC. Exploring the prevalence of gaming disorder and Internet gaming disorder: a rapid scoping review. *Syst Rev.* 2020 Apr 2;9(1):68. doi: 10.1186/s13643-020-01329-2. PMID: 32241295; PMCID: PMC7119162.
- Park JH, Hong JS, Han DH, Min KJ, Lee YS, Kee BS, Kim SM. Comparison of QEEG Findings between Adolescents with Attention Deficit Hyperactivity Disorder (ADHD) without Comorbidity and



- ADHD Comorbid with Internet Gaming Disorder. *J Korean Med Sci*. 2017 Mar;32(3):514-521. doi: 10.3346/jkms.2017.32.3.514. PMID: 28145657; PMCID: PMC5290113.
13. Zhang M, Vallabhajosyula R, Fung D. Emotional Bias Modification for Individuals With Attention Deficit Hyperactivity Disorder: Protocol for a Co-Design Study. *JMIR Res Protoc*. 2020 Dec 23;9(12):e24078. doi: 10.2196/24078. PMID: 33355536; PMCID: PMC7787886.
  14. CHADD C, A with A-DD. About ADHD – Overview. 2018.
  15. Marmet S, Studer J, Grazioli VS, Gmel G. Bidirectional Associations Between Self-Reported Gaming Disorder and Adult Attention Deficit Hyperactivity Disorder: Evidence From a Sample of Young Swiss Men. *Front Psychiatry*. 2018 Dec 11;9:649. doi: 10.3389/fpsy.2018.00649. PMID: 30618855; PMCID: PMC6297670.
  16. American Academy of Family Physician. DSM-5 Diagnostic Criteria for ADHD .DSM-5 Diagnostic and Statistical Manual of Mental Disorders, 5th edition. 2013 [cited 2022 Nov29]. Available from: [https://www.aafp.org/dam/AAFP/documents/patient\\_care/adhd\\_toolkit/adhd19-assessment-table1.pdf](https://www.aafp.org/dam/AAFP/documents/patient_care/adhd_toolkit/adhd19-assessment-table1.pdf).
  17. Li W, Zhang W, Xiao L, Nie J. The association of Internet addiction symptoms with impulsiveness, loneliness, novelty seeking and behavioral inhibition system among adults with attention-deficit/hyperactivity disorder (ADHD). *Psychiatry Res*. 2016 Sep 30;243:357-64. doi: 10.1016/j.psychres.2016.02.020. Epub 2016 Mar 31. PMID: 27449004.
  18. Zhou B, Zhang W, Li Y, Xue J, Zhang-James Y. Motivational but not executive dysfunction in attention deficit/hyperactivity disorder predicts internet addiction: Evidence from a longitudinal study. *Psychiatry Res*. 2020 Jan 25;285:112814. doi: 10.1016/j.psychres.2020.112814. Epub ahead of print. PMID: 32036155.
  19. Ashinoff BK, Abu-Akel A. Hyperfocus: the forgotten frontier of attention. *Psychol Res*. 2021 [cited 2022 Nov 29];3:1–19. Available from: <https://doi.org/10.1007/s00426-019-01245-8>.
  20. WHO. Inclusion of gaming disorder in ICD-11. 14 September 2018.
  21. Swing EL, Gentile DA, Anderson CA, Walsh DA. Television and video game exposure and the development of attention problems. *Pediatrics*. 2010 Aug;126(2):214-21. doi: 10.1542/peds.2009-1508. Epub 2010 Jul 5. PMID: 20603258.
  22. Masi L, Abadie P, Herba C, Emond M, Gingras MP, Amor LB. Video Games in ADHD and Non-ADHD Children: Modalities of Use and Association With ADHD Symptoms. *Front Pediatr*. 2021 Mar 12;9:632272. doi: 10.3389/fped.2021.632272. PMID: 33777866; PMCID: PMC7994285.
  23. Hygen BW, Skalická V, Stenseng F, Belsky J, Steinsbekk S, Wichstrøm L. The co-occurrence between symptoms of internet gaming disorder and psychiatric disorders in childhood and adolescence: prospective relations or common causes? *J Child Psychol Psychiatry*. 2020 Aug;61(8):890-898. doi: 10.1111/jcpp.13289. Epub 2020 Jul 5. PMID: 32623728.
  24. Jeong H, Yim HW, Lee SY, Lee HK, Potenza MN, Lee H. Factors associated with severity, incidence or persistence of internet gaming disorder in children and adolescents: a 2-year longitudinal study. *Addiction*. 2021 Jul;116(7):1828-1838. doi: 10.1111/add.15366. Epub 2021 Jan 28. PMID: 33283397.
  25. Evren C, Evren B, Dalbudak E, Topcu M, Kutlu N. Relationships of Internet addiction and Internet gaming disorder symptom severities with probable attention deficit/hyperactivity disorder, aggression and negative affect among university students. *Atten Defic Hyperact Disord*. 2019 Dec;11(4):413-421. doi: 10.1007/s12402-019-00305-8. Epub 2019 May 6. PMID: 31062235.
  26. Stavropoulos V, Adams BLM, Beard CL, Dumble E, Trawley S, Gomez R, Pontes HM. Associations between attention deficit hyperactivity and internet gaming disorder symptoms: Is there consistency across types of symptoms, gender and countries? *Addict Behav Rep*. 2019 Jan 2;9:100158. doi: 10.1016/j.abrep.2018.100158. PMID: 30671530; PMCID: PMC6327637.
  27. Yen JY, Liu TL, Wang PW, Chen CS, Yen CF, Ko CH. Association between Internet gaming disorder and adult attention deficit and hyperactivity disorder and their correlates: Impulsivity and hostility. *Addict Behav*. 2017 Jan;64:308-313. doi: 10.1016/j.addbeh.2016.04.024. Epub 2016 Apr 29. PMID: 27179391.
  28. Vadlin S, Åslund C, Hellström C, Nilsson KW. Associations between problematic gaming and psychiatric symptoms among adolescents in two samples. *Addict Behav*. 2016 Oct;61:8-15. doi: 10.1016/j.addbeh.2016.05.001. Epub 2016 May 3. PMID: 27203825.
  29. Wartberg L, Kriston L, Kramer M, Schwedler A, Lincoln TM, Kammerl R. Internet gaming disorder in early adolescence: Associations with parental and adolescent mental health. *Eur Psychiatry*. 2017 Jun;43:14-18. doi: 10.1016/j.eurpsy.2016.12.013. Epub 2017 Jan 14. PMID: 28365463.
  30. Schou Andreassen C, Billieux J, Griffiths MD, Kuss DJ, Demetrovics Z, Mazzoni E, Pallesen S. The relationship between addictive use of social media and video games and symptoms of psychiatric disorders: A large-scale cross-sectional study. *Psychol Addict Behav*. 2016 Mar;30(2):252-62. doi: 10.1037/adb0000160. PMID: 26999354.