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COMORBIDITY OF GAMING DISORDER AND ATTENTION DEFICIT HYPERACTIVITY DISORDER (ADHD)

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Abstract

The intensive development of the internet and electronic, high-tech devices has led to an unprecedented popularization of video games. Unfortunately, all of this has been accompanied by numerous negative consequences for the health of their users, which are classified as Gaming Disorder according to ICD-11. Among authors, there is a growing interest in studying the comorbidity of this entity and certain mental disorders. The most well-studied and frequently mentioned is the connection between Gaming Disorder and ADHD. The aim of this work was to review the literature, using databases such as Google Scholar, PubMed, ResearchGate, and MDPI, to gather and systematize scientific knowledge about Gaming Disorder and ADHD individually, as well as about their mutual influence. It has been confirmed that hyperactivity, impulsivity, attention deficits, and altered prosocial behavior are significantly present in both entities, which unequivocally indicates an increased vulnerability of individuals with ADHD to the development of Gaming Disorder, as well as the impact of Gaming Disorder on intensifying the symptoms of existing ADHD. Given the lack of precise diagnostic procedures for determining the degree of dependence and psychological changes in Gaming Disorder and ADHD, further accurate longitudinal studies are necessary to assess the individual impact of already identified risk factors, with the aim of early recognition of comorbidity and its effective prevention and therapy.

Key words: *Gaming disorder, ADHD, comorbidity, risk factors.*

Introduction

At the end of the 20th century and the beginning of the 21st century, the field of video games is marked by the intensive development of the internet and electronic, high-tech devices (computers, tablets, and gaming consoles). The introduction of smartphones into use represented a special technological boom. Their widespread use, easy downloading of games from the internet, and the ability to play "anytime, anywhere" have led to the unprecedented popularization of internet games,

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transforming them from individual entertainment into a global cultural phenomenon. Research conducted in many countries among internet users has shown that as many as 86.3% of them have played some kind of online game [1]. In 2024, there were 3.3 billion registered internet game players in the world, and it is predicted that by the end of 2025 the number will be 3.51 billion [2]. It is predicted that the trend of an annual increase of 0.4 billion internet players will continue in the coming years, so that by 2029 the number will have increased by 15.5 percent [1]. The number of female players is constantly increasing, and today they make up 48% of the world's online player population [3]. The highest percentage of internet gamers is among members of Generation Alpha (born after 2010), standing at 96%, and Generation Z (born between 1995 and 2009), at 92% [4]. On average, every player in the US plays games for at least 1.7 hours per day, while in Europe this number amounts to 1.27 hours [5]. On average, 26% of players spend 1-5 hours a week gaming, 19% spend 6-10 hours, and 7% spend even more than 20 hours [6]. As a rule, the younger someone is, the more likely they are to spend more time playing online games. For example, representatives of Generation Alpha spend 21% of their free time playing online games, for Generation Z this equals 17%, and representatives of all other age groups spend an average of 14% [7].

The fact that an increasing number of children and adolescents play internet games and spend more time in this activity has caused a real explosion of research into their impact on the mental and physical health of the players themselves [8]. All these studies can be categorized into several groups. The first group consists of research that denies significant psychological changes in internet game players [9]. The second group of works confirms the influence of internet games on the player's personality, simultaneously tracking both positive and negative effects [10, 11, 12, 13, 14]. The nature of the resulting changes is mainly determined by the type of game [15, 16] or the time spent playing [17, 18]. Research in the third group focuses exclusively on the positive effects of playing internet games on different categories of players [19, 20, 21]. Fourthly, and for many the most interesting, and therefore the largest group, are studies focusing exclusively on the negative effects of playing video games on their users, such as addiction, signs of depression, social withdrawal, impulsivity, irritability, aggression, anxiety, and suicidal tendencies [22, 23, 24, 25, 26].

A special place among the studies in the fourth group is occupied by studies that indicate the existence of complex relationships, i.e. comorbidity between gaming disorders and mental disorders [27, 28, 29, 30]. However, despite these claims, the precise mechanisms of their formation and the directionality of this connection have not yet been discovered [27]. Based on the significant similarities in behavioral, emotional, and neurochemical characteristics between substance use disorders and behavioral addictions (including gaming disorder), four main models for the development of comorbidity have been established: 1) the common factors model (the same risk factors for both disorders), 2) the secondary mental disorder model (the disorder contributes to other psychiatric disorders), 3) the secondary internet gaming disorder model (the psychiatric disorder exacerbates the gaming disorder), and 4) the bidirectional model (one disorder will increase the vulnerability to the other, which in turn increases the severity of the first) [27].

The best-studied and most frequently cited comorbidities of gaming disorder in the literature are depression, anxiety, attention deficit/hyperactivity disorder (ADHD), obsessive-compulsive disorder, and hostility/aggression [31]. In our work, we focused on the comorbidity of gaming disorder and attention-deficit/hyperactivity disorder (ADHD).

Aim of the study

The existence of comorbidity between gaming disorder and attention-deficit/hyperactivity disorder has been confirmed in numerous studies. The aim of our work is to gather and systematize scientific knowledge about the interaction between gaming disorder and attention deficit hyperactivity disorder through a literature review, using the databases: Google Scholar, PubMed, ResearchGate, and MDPI, in order to determine the directions for further research into all potential clinical implications.

Comorbidity of gaming disorder and attention deficit hyperactivity disorder

Gaming disorder (IGD)

The first classification of disorders related to video game playing was made by the American Psychiatric Association in 2013 by including them in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders - Fifth Edition (DSM-5) under the official name Internet gaming disorder (IGD) [32]. Due to the lack of sufficient evidence to justify including this disorder as a separate clinical entity in Section II of the manual, it has been classified in Chapter III, which includes conditions requiring further research and data collection [33]. Internet gaming disorder is defined in this manual as: "persistent and recurrent use of the internet for gaming, often with other players, which leads to clinically significant impairment or distress" [32]. Although the name of the disorder suggests it is related to playing internet games, offline games are also included. On the other hand, the use of the internet for business, professional, social, and recreational activities is excluded from the disorder. Online gambling is also not part of this disorder but is classified under pathological gambling in the chapter on substance-related disorders [37]. By expert consensus, the manual presents criteria significant for further research into internet gaming disorder, but it is recommended that they can also be used for diagnostic purposes [34]. These criteria are: (1) preoccupation with internet games; (2) experiencing unpleasant symptoms when internet gaming is stopped [withdrawal]; (3) the need to spend more and more time playing internet games (tolerance); (4) unsuccessful attempts to control participation in internet games (loss of control); (5) loss of interest in hobbies and entertainment other than internet gaming (giving up other activities); (6) continued excessive use of internet games despite knowledge of psychosocial problems (continuity); (7) deceiving family members, therapists, and others about the amount of internet gaming (deception); (8) using internet games to escape or alleviate negative moods (escape); and (9) jeopardizing or losing significant relationships, jobs, education, and career opportunities due to participation in internet games (negative

consequences) [34]. To be diagnosed with IGD, users of these games must exhibit at least 5 out of 9 criteria for a period of one year. Depending on the number of present criteria, or the degree of disruption to normal activities, the disorder can be mild, moderate, or severe [35].

According to ICD-11, gaming disorder is manifested by persistent or recurrent gaming behavior ("digital" or "video"), which can be online (via the internet) or offline, and is characterized by: (1) impaired control over gaming (onset, frequency, intensity, duration, termination, context); (2) increasing priority given to gaming to the extent that gaming takes precedence over other life interests and daily activities; and (3) continued or escalated gaming despite the occurrence of negative consequences. The pattern of behavior in gaming results in marked distress or significant impairment in personal, family, social, educational, occupational, or other important areas of functioning [36]. To be diagnosed, these characteristics and the present pattern of gaming must be evident for a period of at least 12 months, although this period can be shortened if all diagnostic requirements are met and symptoms are severe [36].

Attention deficit hyperactivity disorder (ADHD)

Attention deficit hyperactivity disorder (ADHD) is the most common neurodevelopmental disorder [37]. With a global prevalence of 7.2% in children, it is also one of the most common mental disorders in childhood [38]. Attention deficit hyperactivity disorder (ADHD) usually begins before the age of 12 [39]. The evolution of symptoms is often progressive and constant, so they are found in adolescence in 50% to 80% of cases, and in 40% they persist into adulthood [40, 41].

Attention Deficit Hyperactivity Disorder (ADHD) is classified in the latest International Classification of Diseases (ICD-11) manual under the group of neurodevelopmental disorders and is defined as a disorder characterized by a persistent pattern (present for at least 6 months) of inattention, and/or hyperactivity and impulsivity, which has a direct negative impact on academic, professional, or social functioning [36].

In the American Diagnostic and Statistical Manual of Mental Disorders (DSM-5), ADHD is defined as a neurodevelopmental disorder with reduced attention [inattention], disorganization, and/or hyperactivity, or impulsivity [1, 32]. Inattention refers to problems with maintaining concentration on a task, focusing, and organizing. Symptoms of inattention include: (1) not paying attention to details or making careless mistakes in school or work tasks, (2) having trouble maintaining focus on tasks or activities, (3) not seeming to listen when spoken to, (4) not following instructions and not finishing schoolwork, chores, or work duties, (5) having trouble organizing tasks and work, (6) avoiding or disliking tasks that require sustained mental effort, (7) losing things needed for tasks or daily life, (8) being easily distracted, and (9) forgetting daily tasks [32].

Hyperactivity refers to excessive movement such as fidgeting, excessive energy, restless sitting, and talkativeness [32]. Impulsivity refers to decisions or actions taken without considering the consequences. Symptoms of hyperactivity include: (1) fidgeting or tapping hands or feet, or squirming in the seat, (2) difficulty staying seated, (3) running around or climbing where inappropriate, (4) inability to play

quietly or engage in leisure activities, (5) always "on the go," as if driven by a motor, (6) talking excessively, (7) answering before questions are finished, (8) difficulty waiting for their turn, (9) interrupting or intruding on others' conversations [32].
Both manuals, ICD-11 and DSM-5, recognize three clinical forms of ADHD depending on the dominant symptoms, which are classified as subtypes in ICD-11 and as presentations in DSM-5: disorder with predominantly inattentive presentation (attention deficit predominates), disorder with predominantly hyperactive-impulsive presentation, and combined disorder in which symptoms of both previous presentations are present but without significant mutual dominance [36, 37]. Unlike ICD-11, which requires the presence of a specific pattern of symptoms for at least 6 months to diagnose ADHD, DSM-5 requires the presence of at least 6 or 5 (for individuals over 17 years old) symptoms of one of the disorders for at least 12 months [36, 37].

Comorbidity of IGD and ADHD

Many authors state that the association between IGD and ADHD, in both children and adolescents as well as adults, is one of the most common comorbidities of IGD [38, 39, 40, 41]. Supporting such claims are also the findings of Isorna Folgar et al.'s research, which showed that significantly more respondents diagnosed with ADHD (88.6%) reported playing video games compared to healthy respondents (77.7%) [42]. A significant difference in the prevalence of video game playing between these two categories has also been recorded in most other similar studies [41, 42, 43, 44, 45, 46]. Additionally, individuals with IGD show a high prevalence of ADHD symptoms, with values ranging from 29% [47] to 83.3% [48]. The majority of studies examining the age-related prevalence of IGD in individuals with ADHD indicate that it is significantly higher in children and adolescents compared to adults [49, 50]. Ha et al. report a rate of this comorbidity in children and adolescents of 58% [51], while according to Bernardi &Pallanti, it is 14% in adults [52]. Unfortunately, examining internet gaming in individuals with ADHD based on their age, Masi et al. and Marmet et al. concluded that the time spent playing games increases with age in children, meaning their level of addiction increases, which they believe is consistent with the increased vulnerability of children with ADHD to addiction [43, 53]. Similar claims are made by Lemmens et al. stating that earlier initiation of video game playing in children poses a risk of developing IGD during adolescence [54]. Ginsberg et al. [55] also cite adolescence as a high-risk period for the development of addiction among young patients with ADHD. Studies on the distribution of comorbidities related to gender show a significantly higher prevalence in males [49, 50, 56, 57, 58], leading to the conclusion that men with ADHD are a significant risk factor for developing IGD [43].
Most authors consider the time spent playing online games a risk factor for the development of comorbid IGD and ADHD [42, 59, 60]. Its mechanism of action works on the principle of interaction, where more time spent playing can intensify ADHD symptoms [61], and conversely, players with a more pronounced form of ADHD spend more time playing, which can lead to the development of IGD [62]. There is still no consensus on the amount of time spent playing that leads to the onset or deepening

of already present ADHD symptoms. According to Chan & Rabinowitz, this period is over one hour per day [59], while Kietglaiwansiri&Chonchaiya state that all child participants with ADHD symptoms spent more than two hours per day playing games [60].

Comorbidity of IGD and ADHD – mechanism of onset and risk factors

Although the comorbidity of IGD and ADHD has been demonstrated in numerous studies, it has not yet been established whether the relationship between them is unidirectional or bidirectional [43],[63],[64]. A number of authors [60, 65, 66, 67] believe that IGD can be a predictor of attention deficit hyperactivity disorder (ADHD). The time spent playing and the intensity of play also have a significant impact on individuals with ADHD who also have developed IGD. IGD can exacerbate existing symptoms of hyperactivity, reduced attention, and impulsivity, leading to further weakening of impulse control [67]. Bioulac et al., comparing a group of children with ADHD and a control group of healthy children, found a higher number of symptoms associated with IGD and their greater intensity in children with ADHD, which also supports the strong effect of excessive internet gaming on the development of comorbidities [44].

On the other hand, there are authors [68, 69, 70, 71, 72] who start from the assumption that ADHD symptoms lead to the development of IGD. Hawi & Samaha in Salerno et al. state that ADHD symptoms are a significant predictor of IGD severity [57, 73]. A correlation was also established between the severity of ADHD symptoms and IGD, with individuals experiencing more intense ADHD symptoms being more vulnerable to developing IGD [57, 62]. Also, changes in ADHD symptoms significantly influence changes in IGD symptoms, with these symptoms showing a tendency for more difficult recovery and more frequent recurrence compared to IGD in individuals without ADHD [70].

Isorna Folgar et al., Masi et al., and Weiss et al. [42, 43, 74] have pointed out the possible bidirectional relationship between IGD and ADHD as a mechanism for their comorbidity. Supporting these claims are the research findings of Yoo HJ et al. and Hong JS et al., which show that the group with IGD had a higher prevalence of ADHD compared to the general player group, and that the group of players with ADHD had a higher prevalence of IGD compared to the group without ADHD [58, 75].

Many studies are based on demonstrating the presence of the same symptoms in both IGD and ADHD, as well as attempts to explain the mechanism of connection between these two entities through the influence of certain symptoms of one entity on the other [62,76]. In their study, Yen et al. demonstrated a strong association between internet gaming disorder and ADHD, arguing that impulsivity and hostility are significantly present in both disorders and are precisely what mediates the relationship between ADHD and IGD [77]. Hygen points to a significant positive correlation between IGD symptoms and symptoms of ADHD, anxiety, and behavioral disorders [29]. Chen et al. believe that the symptoms of depression and hopelessness present in individuals with ADHD play a significant direct and indirect mediating role in the development and exacerbation of ADHD symptoms [68]. This connection was also pointed out by

Castellanos-Ryan N & Conrod P, who hypothesized that symptoms of depression and hopelessness present in individuals with ADHD reduce their ability to successfully solve problems and fulfill [78]. Hyperfocusing and reduced ability to manage time and prioritize activities in individuals with ADHD are considered by Kooij et al. to be predictors of more severe IGD symptoms [79].

Comparative studies of children with and without ADHD have shown that children with ADHD exhibit hyperactivity, significant deficits in concentration and attention, and problems with daily planning and organization [80, 81]. Such disruptions in social functioning lead to difficulties in forming new and maintaining existing friendships and emotional relationships. Reduced emotional potential in adolescents with ADHD often manifests as disturbed relationships with parents, along with a feeling of insufficient connection and closeness [82]. All these deficits in the areas of thinking, cognition, and emotions, both in childhood and adulthood, lead to low self-esteem and feelings of loneliness and social isolation in these individuals [80]. In such a state of psychological pain, individuals with ADHD resort to excessive use of video games and the internet as a way to self-validate and establish connections and interactions with other people [42, 83]. This sequence most often contributes to the development or worsening of already developed IGD [42, 83, 84].

Simonelli V et al. cite the tendency of children with ADHD to seek sensations and satisfy their impulsive needs for quick rewards as the underlying mechanism for the comorbidity of IGD and ADHD [85].

Comorbidity of IGD and ADHD –
neurobiological mechanism of occurrence

Neurobiological interpretations of comorbidity are mainly based on disturbances in the anatomical structure and physiological mechanisms of the brain. Gao et al. found abnormalities in gray matter volume in both patients with IGD and patients with ADHD [86]. In this case, changes in the thalamus were only registered in IGD, while changes in the orbitofrontal cortex were only found in ADHD. Localization of abnormalities in the prefrontal cortex was a characteristic of both entities [86]. Dekkers & van Hoorn highlight the interpretation that problematic internet media use is conditioned by an imbalance between brain regions involved in reward processing and cognitive control [83]. A large number of studies have shown that the release of larger amounts of striatal dopamine during video game use involves brain reward circuits, which improve concentration ability during gameplay, providing a sense of pleasure to individuals with ADHD [76, 87, 88]. The mediating role of dopamine in the development of comorbidity is also confirmed by the effectiveness of stimulant medications in reducing the severity of symptoms of both ADHD and IGD [89]. The alleviation of IGD symptoms with ADHD medication has also been demonstrated by Weinstein and Weizman [76].

Conclusion

By reviewing numerous studies on all aspects of the comorbidity of IGD and ADHD, we have reached conclusions about the relationship between these entities and their mutual interaction. Although the mechanism of onset is still not reliably established as to whether it is a one-way influence of IGD on the development or intensification of pre-existing ADHD and vice versa, or whether this influence is bidirectional, it is undeniable that there is a positive correlation between the symptoms of these disorders. Namely, the presence of severe symptoms in one entity represents a significant risk factor for exacerbating symptoms in the other entity. This correlation also significantly impacts the poorer outcome of the disorder compared to individuals with isolated IGD or ADHD. Neurobiological research, which is becoming increasingly common, suggests that increased gray matter volume in certain parts of the brain and the mediating role of dopamine in the reward system and sensitization are possible causes of the development of comorbidity. The main directions for future research should focus on several aspects. It is necessary to intensify research to determine the precise causes and mechanisms of IGD and ADHD, as well as their comorbidity, in order to primarily avoid errors in the diagnostic differentiation of IGD with ADHD symptoms and ADHD as a neurodevelopmental disorder. This would allow for the precise identification and isolation of each individual case from an extremely heterogeneous population of individuals with ADHD. At the same time, this diagnostic approach would enable personalized therapeutic treatment aimed at achieving the best possible treatment outcomes. In all procedures, both in research and clinical practice, parents of children and adolescents with ADHD should be involved as much as possible, both in terms of resolving disrupted family relationships and in training to recognize the first symptoms of excessive internet gaming.

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