

Video Games in Adhd and Non-Adhd Children: Modalities of Use and Association with Adhd Symptoms

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Introduction

Children and adolescents report playing video games frequently, and there is a trend that this use is being reported at an ever-younger age (1). For example, 91% of children aged 2 to 17 years are reported to play video games (2). New games on smartphones or tablets are rapidly being developed, many of which target young children, including toddlers (3). The use of screens starts at an early age with more than 30% of children who have used a tablet before the age of 2, and often for playing video games. From about the age of 4, the computer has been shown to be an increasingly popular medium for children to play video games (4). When children get older, a vast array of devices are used such as consoles, computers, tablets, smartphones, whether online or offline.

The period between 4 and 12 years is therefore an important stage where children are increasingly exposed to video games and as such represents a relevant developmental period to study factors linked to excessive or addictive use of video games. Studies tend to show that approximately 2.0% to 5.5% of adolescents/young adults demonstrate an addiction to video games (5). Multiple factors including the types of video games, personality characteristics and early exposure contribute to this addiction, but its origins are complex, and gaps exist, particularly pertaining to such use by children (6).

The World Health Organization (WHO) introduced the Gaming Disorder (GD) in 2018 to the International Classification of Disease-11 (ICD-11) (7). And highlighted three symptoms: “impaired control over gaming, increasing priority given to gaming and continuation or escalation of gaming despite the occurrence of nega-

tive consequences” (8). Similarly, the Internet Gaming Disorder (IGD) appeared in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) in 2013 but it was categorized as requiring further study and not sufficiently well established to be a part of the official classification of mental disorders for routine clinical use (9). IGD requires experiencing five or more of the following symptoms within a year: “preoccupation or obsession, withdrawal, tolerance, loss of control, loss of interest, continued overuse, deceiving, escape of negative feelings, functional impairment” (10). In this article, we will use the expression video game addiction which, in summary, shall be interpreted as a repeated use of video games that results in a significant impairment to an individual’s social, family or professional life over a prolonged period of time.

The association between Attention Deficit Hyperactivity Disorder (ADHD) symptoms and video game addiction is observed among children and adolescents but remains poorly understood (11). The relationship between ADHD and the excessive use of video games may likely be bi-directional and needs to be clarified. In addition, most studies have been done in adolescents, and data for preschool children are almost non-existent apart from a study by Paulus et al. in 2018 (12). ADHD is a risk factor for addictions in general (13). And it is the most frequent psychopathology in video game addiction (14). It is already listed in the DSM-5 as comorbid with Internet Gaming Disorder (15). However, the use of online games is mostly found in adolescents and young adults and less in children who usually start with offline video games (16).

In order to better understand the relationship between video game

use/addiction and ADHD in preschool/school children, we conducted a descriptive and exploratory study with the following objectives:

1. To determine the modalities of use of video games (playtime, addiction score and usage by age) in children with ADHD as compared to children without ADHD.
2. To examine the associations between video game addiction and ADHD symptoms.
3. To explore the gender difference in video game use and the type of video games played by children with ADHD.

Methods

Study Design

The study was cross-sectional, multicenter (CHU Sainte-Justine, CIUSSS of North Island of Montreal) in child psychiatric departments, exploratory and descriptive. We recruited three groups of children aged 4 to 12 (as defined below). The material used consists of questionnaires to be completed by one of the parents for each group. Data collection took place from December 2016 to August 2018 in Montreal.

The first of the three groups consisted of children with ADHD (the “ADHD Group”). The second group consisted of children with one or more diagnosis in mental health (the “Clinical-Control Group”) excluding ADHD, recruited from child psychiatry outpatient clinics. The third group consisted of children from the community from found in schools and day camps in the Greater Montreal area (the “Community-Control Group”). Children in this group are characterized by the absence of any major dysfunction.

For the ADHD Group and the Clinical-Control Group, medical records have been consulted by a research assistant in order to obtain the psychiatric diagnosis. ADHD and/or any psychiatric diagnosis have all been issued by a child psychiatrist based on the validated diagnostic criteria of the DSM-5 (17).

The exclusion criteria for parents and children were to not be able read, write and understand French. Participants ought not to have an intellectual disability or to be actively psychotic.

Measures

Sociodemographic Data

Sociodemographic questionnaire with specifications concerning the use of video games

Parents completed a sociodemographic questionnaire in order to find out the amount of screen time children used during the week and the weekend, the types of games they played (creative, edu-

cational, violent games) and whether or not parents played as well (18).

Psychometric Data

QUATTORD (*Questionnaire de l'attention et de l'ordinateur*)

Parents completed the QUATTORD questionnaire (a French attention and computer questionnaire) for assessing the symptoms of ADHD and the use of video games. Questions about ADHD symptoms and addiction symptoms are based on the diagnostic criteria of the DSM-5. It has been used by Paulus in a study on ADHD and video games of more than 1,000 German preschool and school-aged children (19). The results obtained from this questionnaire yielded empirical data in agreement with the literature.

SDQ (*Strengths and Difficulties Questionnaire*)

The SDQ questionnaire consist of 25 items to assess skills (e.g., prosocial behaviors) and difficulties (e.g. hyperactivity) in children and teenagers aged 4 to 16 (20). Cronbach’s alpha for the total difficulty score was 0.77, which is acceptable (21). The goal was to use an additional independent assessment (independent from the QUATTORD) to have an overview of the children’s general internalizing and externalizing behaviors.

Statistical analysis strategy

First, ANOVA (analysis of variance) were conducted to compare video game playtime and addiction scores according to QUATTORD between the three groups of study and between age categories for each group (4-6, 6-8, 8-10 and 10-12 years-old). We then clarified the differences found by post-hoc analyses (Hochberg and Games-Howell). Correlation analyses were then used to assess associations between severity of ADHD symptoms and SDQ items in relation to dependency. We then conducted a multiple regression analysis to explore the combination between the gender and to be ADHD or to have a clinical diagnosis. The statistical significance threshold was $\alpha = 0.05$.

Results

Descriptive Analyses

A total of 280 participants completed the study: 98 participants (35.0%) in the ADHD Group, 37 participants (13.2%) in the Clinical-Control Group and 145 in the Community-Control Group (51.8%) (Table 1). Participants were exclusively French Canadian and Caucasians. The mean age was 7.68 years and there was no significant difference between the three groups with respect to age ($p > 0.005$). For the gender, the proportion of boys and girls in the study for each group are also presented in Table 1.

Table 1: Proportion of boys and girl in each group

Gender	Total	ADHD group	Clinic-Control group	Community-Control group
Boys	183 (65.4%)	79 (80.6%)	31 (83.8%)	73 (50.3%)
Girls	97 (34.6%)	19 (19.4%)	6 (16.2%)	72 (49.7%)
Total	280	98 (35.0%)	37 (13.2%)	145 (51.8%)

Modalities of Use Between Adhd and Non-Adhd Children

ANOVA showed that the video game playtime was significantly higher for the ADHD Group compared to the Community-Control

Group during both weekdays and weekends. The Hochberg and Games-Howell post-hoc analysis between the 3 groups were significant and identical for video game playtime on weekdays and

weekends. They indicated a longer time spent on video games in the ADHD Group ($p = 0.002$ for ANOVA and post-hoc analysis) (Table 2).

Table 2: Playtime during the week and the weekend

Group	Mean number of hours during the week	Mean number of hours during the weekend	p-value with respect to Community-Control Group
ADHD Group	2.05	3.01	0.002 for week and weekend
Clinical-Control Group	1.86	2.93	0.335 for week and 0.135 for weekend
Community-Control Group	1.44	2.36	NA

Statistically significant $p \leq 0.05$

We compared video game addiction scores obtained at the QUAT-TORD by ANOVA. Addiction was significantly higher for the ADHD Group compared to the Community-Control Group ($p = 0.000$ for ANOVA and post-hoc analysis) (Table 3).

Table 3: Addiction scores for video games

Group	Addiction Score	p-value with respect to Community-Control Group
ADHD Group	1.1025	0.000
Clinical-Control Group	0.9355	0.119
Community-Control Group	0.6802	NA

Statistically significant $p \leq 0.05$

For all groups, we compared the time spent on video games between age categories by ANOVA. Since differences were only significant in the ADHD Group, we then conducted a post-hoc analysis in this group only: we found that time spent on video games was significantly higher for age group 10-12 compared to age group 4-6 during weekdays and weekends (Table 4).

Table 4: Usage during the week and the weekend among age categories of the ADHD Group

Age Category	Mean number of hours during the week	Mean number of hours during the weekend	p-value with respect to the 10-12 years-old age category
4-6 years-old	1.54	2.32	0.005 for the week and 0.000 for the weekend
7-9 years-old	1.95	2.95	0.027
10-12 years-old	2.69	3.79	NA

Statistically significant $p \leq 0.05$

Associations Between the Severity of Adhd Symptoms and Video Game Addiction

There was a significant correlation (Pearson correlation) for each

symptom of ADHD (impulsivity, inattention, hyperactivity) and video game addiction. The strongest correlation was with impulsivity (Table 5).

Table 5: Correlation between symptoms of inattention, hyperactivity, impulsivity and video game addiction

Symptoms	Video game addiction	p-value
Inattention	0.279	0.000
Hyperactivity	0.294	0.000
Impulsivity	0.310	0.000

Statistically significant $p \leq 0.05$

There was a significant correlation ($r = 0.182$ for p -value = 0.003) between hyperactivity symptoms and weekend use time. There was no significant correlation for the other symptoms (inattention and impulsivity) and the time of use during the weekend. Similarly, we did not find a positive correlation for the symptoms of ADHD and the time of use of video games during the week.

Relationship Between Sdq Items and The Use of Video Games

All correlations between SDQ items and video game addiction scores found by the QUATTORD are highly significant with $p < 0.01$: Positive correlations with emotional problems (0.321), conduct disorders (0.293), hyperactivity (0.242) and peer problems (0.201); and negative correlation with prosocial abilities (-0.272).

Correlations between SDQ items and playtime during the week are positive and significant for hyperactivity (0.151) and peer problems (0.143) as well as emotional problems (0.208) (highly significant for this last correlation with $p < 0.01$). Correlations between SDQ items and playtime during the weekend are positive and highly significant ($p < 0.01$) for emotional problems (0.242), conduct disorders (0.164) and hyperactivity (0.229).

Exploratory Results

According to our regression analyses looking for variables predicting addiction, we found a significant interaction between addiction, clinical groups and gender, based on a linear regression (0.533). That is, the boys in the study showed more dependence if they belonged to one of the 2 clinical groups (ADHD Group and Clinical-Control Group) and, more specifically, ADHD boys had the highest addiction scores. We did not find this trend for girls whose addiction scores were equivalent regardless of the group (Clinical-Control Group or Community-Control Group).

With respect to the types of games played, 62 participants (24.8%) often played creative games (e.g. Minecraft), 66 participants (26.5%) often played educational games (e.g. Oregon Trail) and 51 participants (8.4%) often played violent games (e.g. Call of Duty). With respect to parents, we found that only 17.4% of parents played video games at all.

Discussion

Research on the relationship between ADHD and video game addiction has mainly been conducted in adolescents and young adults, and studies focusing on children, like ours, are rare (22). Our study highlighted a vulnerability in ADHD children as they exhibit more addictive behaviors with respect to video games and demonstrate prolonged periods of use. We also observed a correlation between the severity of ADHD symptoms and excessive use of video games. Finally, our results suggest that the association between the male gender and ADHD is an additional risk factor for the excessive use of video games.

Modalities of Use and Comparison Between Adhd and Non-Adhd Children

The duration of use was significantly higher in the ADHD Group compared to the Community-Control Group, during both the week and the weekend. We also found that, in accordance with the literature, when the symptoms of ADHD are more severe, the play-

time would be significantly longer (23). These results indicate that caution is necessary when children with ADHD play video games.

Furthermore, the degree of video game addiction was also significantly higher in children with ADHD compared to children in the community group. In the former, we indeed found, as early as pre-school age, a greater vulnerability to develop addictive behaviors towards video games compared to children of the same age without ADHD (24). This would be even more important in ADHD children with behavioral problems since they might be less able to accept a certain control over their playtime (25). In addition, ADHD patients are at risk of addictive behavior and, more specifically, an ADHD diagnostic should increase the risk of being dependent on online video games (26).

The explanatory mechanisms of this attraction by ADHD patients to video games include becoming bored quickly, intolerance to waiting, difficulties in self-control, difficulties being motivated, the need for intense stimulation and difficulties in interpersonal relationships (25). On the other hand, studies in neurobiology have shown a release of striatal dopamine involving the brain reward circuits during video game use improving the ability to concentrate during playtime which would provide a sense of comfort for young ADHD (27, 28). Risk factors for the development of addiction to video games are also typical traits of ADHD such as impulsivity, difficulty in managing emotions and lack of prosocial capacity (29). Video games finally seem to allow young ADHD patients to offset the frustrations and failures of real life with the successes and achievements they perceive while playing, which largely explains their appeal (30).

Comparison of Usage by Age

The only significant difference found was in the ADHD Group for the age category 10-12 compared to 4-6 with a longer playtime among 10-12 years-old during the week and the weekend. According to Lemmens, the younger the video games are played, the higher the risk of developing addiction during adolescence, a period of vulnerability to addictive behavior (31). Indeed, early and regular exposure to video games with long playing sessions is one of the most important risk factors for cyber addiction (32). According to our results, this risk factor is even more present in the ADHD Group which presents at its basis vulnerabilities to addiction.

ADHD children seem to show an increase in video game playtime as they get older, while the other two groups of children do not differ by age. This may mean that early exposure by a young ADHD is a risk factor for the increasing use as he/she gets older, especially at the dawn of adolescence and during adolescence. Indeed, adolescence is for a young ADHD a high-risk period for addictions (33).

Associations Between Adhd Symptoms and Video Game Addiction

We observed a significant correlation between all symptoms of ADHD and those of video game addiction. According to Yen, the symptoms of ADHD (inattention, hyperactivity and impulsivity) among ADHD patients who are also cyber addicts would indeed appear with more intensity than in ADHD patients who are not.

More specifically, inattention seems to be the most aggravated symptom of video game abuse (34). However, in our study, impulsivity appears to be the most correlated to addiction to video games. This is consistent with Bioulac's hypothesis that ADHD children would also have more behavioral problems related to video games (35). In the same vein, the higher the frequency young people consult their smartphone, the greater the risk to develop ADHD symptoms (36).

Thus, there appears to be a link between the symptoms of ADHD and the excessive use of video games, although at this stage it is not possible to predict the direction of causation. Moreover, it is important to differentiate the symptoms of ADHD that result from an excessive use of video games from ADHD as a neurodevelopmental disorder.

Association Between Sdq Items and The Use of Video Games

We found a highly significant positive association between behavioral problems on one hand, and video game addiction and playtime during the weekend on the other. The uncontrolled use of screens during childhood, whether for video gaming or not, would therefore lead to a high risk of behavioral difficulties. Similarly, according to a study by Poulain (2018) among children aged 2 to 6 years, the use of screens (including video games) is a major risk factor for the development of behavioral difficulties (37). Moreover, there is a strong association between early exposure to screens and the subsequent development of aggressive and antisocial behaviors (38, 39). With all those results, including ours, it appears that excessive use of video games may influence negatively on emotional and behavioral problems and on the well-being of children from the early years of their lives.

We obtained a positive and significant correlation between socialization difficulties and video game addiction and playtime during the week, while the association between video game addiction and prosocial abilities was negative. Indeed, according to the literature, there is a strong association between increased screen time and reduced social development in children (40). Socialization difficulties are risk factors for video game addiction (41) and at the same time, they will be encouraged by the use of screens by pushing young people to overuse them in avoidance behaviors. Among young people socially not at ease and with a sense of failure in their lives, online interactions will reduce negative feelings such as loneliness and boredom (42). That being said, when parents limit and monitor screen time, children would develop better prosocial skills.

Exploratory Results

We looked for the implication of gender and more specification for the use of video games. First, a majority of boys were in both clinical groups (ADHD Group and Clinical-Control Group). This corresponds to the clinical and epidemiological reality where the sex ratio for ADHD is two boys for one girl and where other neurodevelopmental disorders are also predominantly found in males. Moreover, according to Paulus (2018), more boys than girls have video game consoles, and more girls than boys are nonplayers (43). We have looked for covariables that influence addiction through a regression analysis. According to this regression, if we look at

the interactions between groups and gender, ADHD boys appear to be the most at risk of video game addiction compared to boys in the other two groups. On the other hand, there does not seem to be any differences with respect to girls. Boys with a diagnosis in child psychiatry, ADHD, therefore, seem to be the most vulnerable to video game addiction. It would then be a question of orienting the evaluation and care according to this fragility, which should not be neglected.

It should be noted that studies on video games do not usually take into account the type of video games played, yet it seems essential to begin to make those specific distinctions if we want to make accurate recommendations. There are indeed many different types of video games and different ways of playing that likely have an impact on potential overuse. In this preliminary study, we tried to describe the games played by the children in order to get a first overview of the situation. We found that the most popular video games played for the 4-12 years-old were educational games and not violent games. Educational games (games designed for a primary purpose other than pure entertainment) have pedagogical virtues that can be particularly useful for children with learning difficulties (44). This type of data can be used to refine future research and analysis in order not only to prevent the negative aspects of video games but also to optimize their use.

No data exists for the use of video games by parents. In our study, we found that a majority of parents do not play video games at all. This has an impact on the parents' understanding and management of video games. Ideally, it is recommended that screen time be shared between parents and children according to the guidelines of the Canadian Pediatric Society (45). Poor relationships with parents, poor parental control, hostile parenting, and lack of a rule on the use of screens are risk factors for video game addiction. Parents must rather serve as a role model in the use of screens (46).

Strengths and limitations

Strengths

One of the strengths of our study is the population concerned: research focusing on children is rare and almost non-existent for preschoolers. Also, unlike the majority of ADHD studies where the diagnosis is not confirmed, our participants' diagnosis of ADHD was made following a full evaluation in specialized child psychiatry clinics.

Limitations

The results of this study should be interpreted in light of its limitations. Since the questionnaires are completed by the parents themselves, there may be a measurement bias related to their subjectivity. In addition, the possibility of an ADHD diagnosis in the community population has not been eliminated and could lead to a bias in the results. Lastly, it must be noted that the study is not longitudinal, and we were also not able to test any mechanisms that could explain patterns of findings.

Conclusion

Results from our study demonstrate more addictive playing behaviors in ADHD children, which is of particular concern. Some caution is needed with respect to the use of video games in the pediatric population (e.g. the establishment of a routine to avoid

excesses). To avoid pitfalls, early prevention and specific advice to parents with the establishment of clear rules seem necessary. Moreover, the two-way causal link between ADHD and video games needs to be further explored.

Although we understand that video games present risks, it would still be interesting to look at the benefits they can bring. Indeed, it is important to note that they can also help in the development of skills such as a sense of control and coordination (47). There is a definite interest in using them as a lever for young people by offering new educational and therapeutic perspectives.

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