



RESEARCH ARTICLE

The relationship between probable ADHD and playing MMORPGs with the severity of disordered gaming: The effect of gaming motivations

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ABSTRACT

Objective: The main aim of the present study was to consider the impact of gaming motivations among young adults when evaluating the relationship between probable attention deficit hyperactivity disorder (ADHD) and massively multiplayer online role-playing games (MMORPGs), with disordered gaming.

Method: In the present study, participants were assessed with the Adult ADHD Self-Report Scales (ASRS-v1.1), the Motives for Online Gaming Questionnaire (MOGQ), and the nine-item Internet Gaming Disorder Scale-Short Form (IGDS9-SF).

Results: Participants with probable ADHD (n=143, 19.2%) and without probable ADHD (n=602, 80.8%) did not differ according to the current age, gender, presence of romantic relationship, marital status, where and with whom they are living, employment status and time spent on the gaming. Compared to participants without probable ADHD, those with probable ADHD had higher rates of having a game console, purchasing games, gaming more than usual on weekends, having problems related to gaming, probable internet gaming disorder (IGD) according to IGDS9-SF cut-off score and higher scales scores (IGDS9-SF and MOGQ), whereas they had a lower age at first gaming. Among different game types, those with probable ADHD were gaming more with multiplayer online battle arena games, social network games, music games, MMORPGs, sports games/car games, and horror-themed/survival games. Scores of all six types of gaming motives were higher among those with probable ADHD, and among them coping/escape, social, skill development, and fantasy distinguished the presence of probable ADHD. In the ANCOVA analysis, the presence of probable ADHD and the use of MMORPGs (as well as online gaming motives [coping/escape, recreation, fantasy, social and competition]) predicted the severity of IGD symptoms, and also these effects also interacted, involving probable ADHD and using MMORPGs.

Conclusion: These findings suggest that those with probable ADHD may have different gaming characteristics than those without probable ADHD. Probable ADHD and using MMORPGs are related to the severity of disordered gaming, along with almost all type of online gaming motivations. Also, the effects of probable ADHD and MMORPGs use interacted with each other.

Keywords: Attention deficit hyperactivity disorder, game genre, internet gaming disorder, motivations for online gaming, young adults

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INTRODUCTION

Online and/or offline gaming is one of the most popular leisure activities in the world, particularly for adolescents (1). The gaming can become pathological for some players when the behaviour is dysfunctional and unmanageable, despite related problems such as poor social, professional, family, school, and psychological functionality of the player (2-4). Previous studies have shown that excessive gaming participation can lead to Internet Gaming Disorder (IGD) (5). These studies on the clinical importance of gaming, its health burden, and the neurobiological similarities with other addictive disorders (6) led to the inclusion of IGD both in the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) as “a condition that requires further research before being fully recognized and accepted as an independent disorder in subsequent publications of the DSM” (7,8) and in the International Classification of Diseases 11th Revision (ICD-11), namely Gaming Disorder, as “a mental disorder” (9). Although attention deficit hyperactivity disorder (ADHD) has been associated with IGD (5), early studies mostly evaluated the association of ADHD with internet addiction (IA) (10,11), suggesting a relationship between these two conditions. A strong association was found between ADHD and IA, even after controlling the effects of personality traits, depression, and anxiety symptoms among both Turkish university students (12,13) and university students in Far Eastern countries (14,15). The findings of these studies were also supported by other studies (16-18), and this strong association between IA and ADHD was suggested to be more significant for ADHD symptoms in young adults compared to ADHD in adolescence (17). A consistent similar association was found between IGD and ADHD (19-22). According to a recent review (23), correlations between IGD and ADHD are high. Among the eight studies discussed in this review, four of them found large (24-27), two of them found small (28,29), and one of them found moderate (30) effect sizes for the relationship between IGD and ADHD, whereas only one of them with a longitudinal design found no association between these two variables (4). One of the studies that found a large effect size for the association between IGD and ADHD suggested that this association is mediated by impulsivity and hostility (27). Evren et al. (31) suggested that the severity of both IA and IGD symptoms are associated with probable ADHD together with aggression and depression. In another research conducted by the same author group (32), probable

ADHD and alexithymia were associated with the severity of disordered gaming among university students, even when controlling the effects of depression and anxiety. According to a recent study, the current ADHD symptom, particularly inattention, appears to mediate the effect of immersive tendency on IA and IGD (33). A study conducted in Australia and the U.S.-North America reported that those with more ADHD symptoms showed higher rates of behaviours related to disordered gaming (34). A recent study using the game and player statistics predicted ADHD with an accuracy of 81.8% in a multiplayer online battle arena (MOBA) game of Player Unknown's Battlegrounds (5). Finally, Chang et al. (35) reported that disordered gaming may strongly arouse emotional dysregulation and the future DSM criteria could consider these young people with disordered gaming as a specific ADHD sub-class.

While video games may be overused without being regarded as an addiction (36), excessive gaming is usually associated with disordered gaming; i.e. addictive massively multiplayer online role-playing game (MMORPG) use is positively correlated with the weekly time spent playing MMORPGs (37). Among the large samples of the adult (38,39) and adolescent (40) gamers, time spent for gaming varies significantly between different game genres, as ‘real-time strategy’ (RTS) and ‘role-playing games’ (RPG), in particular MMORPGs (40) found to be played for the longest periods of time. RPGs are intended to immerse the player in a rich and complex narrative connected to the player's character/avatar creation. The creation of avatars has actually been described as a long and persistent process (41). Finally, while the time spent playing both online and offline games is associated with disordered gaming, much more stronger associations in online games (42).

Certain video game genres are more strongly associated with disordered gaming (43). RPG users (44) and MMORPG users (45) showed significantly higher IA scores. Compared to action and other games (e.g. phone games), RTS and RPGs were more strongly associated with pathological play (46). MMORPG and first-person shooter (FPS) players met the IGD criterion more frequently than participants in the other two categories (RTS and sports games) (47). A recent study found that the risk of IGD in secondary school students was 1.52 times higher in RPGs types, 1.59 times higher in simulation games, and 1.51 times higher in MOBA (48). There is growing concern about the addictive potential of MMORPG (43,49). Playing MMORPGs seems to be particularly problematic, as these games require a high degree of commitment and time

investment from the players to the detriment of employment, social and other recreational activities, and relationships (50). Also, RPGs and MMORPGs have the highest enjoyment ratings (51). Studies that evaluated MMORPGs suggested their addictive potential (52-54), in relation to their specific structural features (55,56).

Although the time investment is a predictor for disordered gaming, gaming motivations are stronger predictors (50). Therefore, when investigating the effects of video gameplay on behaviours, it is essential to examine the underlying psychological motives pushing individuals to engage with the activity. Researches have been conducting on the psychological motivations for playing video games for over two decades (57). Although a few gaming motivational factors have been proposed in early researches (58,59), one of the currently most used motivational typologies for gaming behaviours was developed in a study involving 3.818 gamers (60). In their study, Demetrovics et al. (60) suggested the following seven key motivational factors in gaming behaviors: social, escape, competition, coping, skill development, fantasy, and recreation. A review by King et al. (61) suggests that while MMORPG involvement has the strongest positive association with disordered gaming, stronger gaming motivations (e.g., escape, success) are one of the important player vulnerabilities. Regarding the motivations for MMORPG players; success (37,62), escape (37,50,62,63), socialization (37,62), and exploration motives (50,62) were stated. Examining the interests of the genre and the underlying motives for choosing a game may help the individual player gain a more in-depth understanding (64). Hence, there are important questions to be answered; what types of games might players with probable ADHD choose to play and what their motivation would be? Since game genre and gaming motives are closely related to the risk of disordered gaming, the answers to these questions may shed light on recognizing and preventing the early symptoms of IGD among those with probable ADHD.

Although the association of disordered gaming with probable ADHD (23,31,32) and with MMORPG (47,48,50) has been previously investigated, no studies have evaluated the effects of these two variables on the severity of disordered gaming together, and have controlled the effects of gaming motives on these relationships, which can reveal important and novel findings. The hypothesis of this study is that probable ADHD and playing MMORPG, even while controlling

the effects of game motives, may both be associated with disordered gaming. Thus, the present study aimed to evaluate the relationship of disordered gaming with probable ADHD and MMORPG while controlling the effects of gaming motives.

METHOD

Participants and Procedure

A cross-sectional online survey was conducted among e-sports players and university students. Initially, data were collected from players. Their communication information was obtained from the database of ESL Turkey Amateur e-sport players (an organizer company for e-sports tournaments in Istanbul) and Taleworlds Entertainment (game development company in Ankara). Also, an online survey link in Turkish was distributed across the gaming forums. Finally, data were collected from the Turkish-speaking university in Ankara. Those who reported they did not play any games were excluded from the study.

The protocol of the study was approved by the Ethical Committee of Cankaya University (Ankara, Turkey). Involvement in the study was anonymous and confidential. The Plain Language Information Statement was given to the participants, and their informed consent was registered online. The data collected via Qualtrics. No sanctions were imposed on students for not participating. Cankaya University students were rewarded with bonus credit for their participation. Bonus credits were added to their overall score of particular courses.

The online survey was initiated for 980 potential participants. During the initial phase of the data collection, which took place from 4 March to 12 April 2019, 370 amateur or professional gamers initiated the online survey; 264 of them were included in the study because participants (n=106) with systematically missing data were taken as dropouts and their data were excluded from the study. Although these participants gave informed consent, the survey was not fully completed and was ultimately excluded from the study. None of these groups selected the "I never play video games" option. In the second phase of the data collection, which took place from 16 April to 29 May, 610 university students started the online survey, 481 of which were included in the study and as the rest of 58 university students did not fully complete the survey and 71 marked the "I never play video games" option. Thus, the total number of participants included in the study was 745.

The mean age of the sample was 23.06 years ($SD=5.07$; Minimum=11, Maximum=60). Of these, 513 were male (68.9%) and 232 were female (31.1%). While 13 (1.7%) of the participants reported themselves as a “professional e-sports gamer” (regularly receiving a monthly salary), 43 (5.8%) reported themselves as an “amateur e-sports gamer” (having a team and earning money by taking part in the tournaments), 208 (27.9%) as “play games for his/her own pleasure and/or follow e-sports” and 481 (64.6%) as “university student who frequently play games on the Internet”. The first three groups were considered together as “gamers” ($n=264$, 35.4%), whereas the last group as “students” ($n=481$, 64.6%).

Measures

Gaming Time: Weekly gaming time ranges were as follows: (1) “less than seven hours a week (less than one hour per day)”, (2) “7-14 hours a week (1-2 hours per day)”, (3) “15-28 hours a week (2-4 hours per day)”, (4) “29-42 hours a week (4-6 hours per day)”, and (5) “more than 42 hours a week (more than 6 hours per day)”.

Motives for Online Gaming Questionnaire (MOGQ): MOGQ was used to evaluate online gaming motives (60). MOGQ is a self-report tool with 27-items and 7 motivation dimensions; Social, Escape, Competition, Skill Development, Coping, Fantasy, and Recreation. Social motivation covers the need for gaming and making friendships. Escape refers to playing video games to avoid challenges and difficulties in real life. Competition is about beating others, while skill development is about improving the gamers’ own performance, concentration, and other skills. Coping means gaming to minimize stress, anxiety, or anger as well as to get into a better mood. Fantasy relates to searching for new identities and/or behaviours in the sense of virtual gaming that are not possible in gamers’ daily lives. Finally, recreation motive dimension evaluates playing the game for entertainment (60,65,66). The MOGQ uses a “never” to “almost always/always” 5-point Likert scale with higher scores suggesting higher severity of that particular motivational dimension. The dimensions of the MOGQ showed good internal consistencies, ranging from 0.79 to 0.90 (60). The validation study of the Turkish version (67) showed that the six-factor structure (Coping and Escape computed a single factor as Coping/Escape) of the MOGQ was satisfactory. The Turkish version had internal consistencies ranging from 0.87 to 0.92 (67).

Internet Gaming Disorder Scale-Short-Form (IGDS9-SF): The IGDS9-SF measures the symptoms and severity of disordered gaming and its negative

consequences by evaluating online and/or offline gaming behaviours over a 12-month period (68). The IGDS9-SF contains nine items that reflect the nine basic criteria defined by the DSM-5. They are answered on a five-point Likert scale ranging from “1” (never) to “5” (very often), and higher scores in the IGDS9-SF are correlated with higher severity of disordered gaming. The Turkish version of the scale used in this study (69) had high internal consistency (Cronbach’s $\alpha=0.89$).

Adult ADHD Self-Report Scales (ASRS-v1.1): The ASRS (70) is an 18-item self-rating scale, which evaluates ADHD symptoms according to DSM Fourth Edition (DSM-IV-TR) criteria (71). Psychometric evaluation of the Turkish version of the scale among university students showed that it has good reliability and validity (72). ASRS is also a short 6-item screening measure developed for community-based studies and exhibits strong consistency with clinical diagnoses as well as accurate psychometric properties (73-75). The items are answered on a five-point Likert scale ranging from “never” (0) to “very often” (4). Responses given “2” or more (sometimes or more) to items 1-3 is equal to 1 point, while responses given “3” or more (often or more) to items 4-6 were scored with one point. A total score of 4 or more is considered a probable ADHD case.

Statistical Analysis

The analyses were conducted using IBM SPSS Statistics Version 20. Data cleaning was carried out by examining the cases with substantial missing values among the main measures before the analysis. When comparing categorical variables, the χ^2 statistics was used. Odds ratios (OR) and 95% confidence intervals were calculated. We used Student’s t test to compare the groups on continuous variables. Correlations between the daily hours spent on MMORPG gaming last month, severity of IGD symptoms and online gaming motives were evaluated with Spearman correlations, whereas correlations between the severity of IGD symptoms and online gaming motives were evaluated with Pearson correlations. Logistic regression analysis was used to determine predictors of probable ADHD, while taking game genres as independent variables. AN-COVA analysis was performed by taking the severity of IGD symptoms as the dependent variable, possible ADHD and playing MMORPG as fixed independent factors and the severity of play motives as covariates. For all statistical analysis, p values were two-tailed, and associations were considered significant at $p<0.05$.

RESULTS

Participants with probable ADHD (n=143, 19.2%) and without probable ADHD (n=602, 80.8%) did not differ by current age, gender, presence of romantic relationship, marital status, where and with whom they live, occupational status and time spend on the gaming.

Compared to participants without probable ADHD, those with probable ADHD had higher rates of having a game console, buying games, gaming more than usual on weekends, having problems related to gaming, presence of probable IGD according to the IGDS9-SF cut-off score, and higher scale scores (IGDS9-SF and MOGQ), whereas lower age at the first gaming (Table 1).

Table 1: Comparison of sociodemographic and clinical variables according to the presence of probable ADHD

	Probable ADHD				χ^2	df	p
	Present		Absent				
	n=143	19.2%	n=602	80.8%			
	n	%	n	%			
Age (Mean±SD)	22.87	3.45	23.10	5.33	t=-0.499	743	0.618
Gender					0.259	1	0.611
Male	101	70.6	412	68.4			
Female	42	29.4	190	31.6			
Romantic relationship	70	49.0	256	42.5	1.939	1	0.164
Marital status					0.801	3	0.849
Married	9	6.3	29	4.8			
Divorced	1	0.7	7	1.2			
Single	126	88.1	533	88.5			
Other	7	4.9	33	5.5			
Living					4.374	4	0.358
Alone	18	12.6	56	9.3			
with partner	11	7.7	27	4.5			
.with roommate	16	11.2	67	11.1			
.withfamily	88	61.5	411	68.3			
.in dorm	10	7.0	41	6.8			
Occupation					3.632	4	0.458
Working	16	11.2	74	12.3			
Part-time worker	4	2.8	21	3.5			
Unemployed	7	4.9	29	4.8			
Student	115	80.4	457	75.9			
Other	1	0.7	21	3.5			
Do you have a game console where you live?^a	61	42.7	198	32.9	4.860	1	0.027
Do you purchase games?^b	105	73.4	388	64.5	4.158	1	0.041
Time spent on gaming^a, hours (n, %)					3.494	4	0.479
Less than 7 h/pw (Less than 1 h/pd)	37	25.9	168	27.9			
More than 7 hours, less than 14 h/pw (More than 1 hour, less than 2 h/pd)	30	21.0	148	24.6			
More than 15 hour, less than 28 h/pw (More than 2 hours, less than 4 h/pd)	39	27.3	135	22.4			
More than 29 hour, less than 42 h/pw (More than 4 hours, less than 6 h/pd)	19	13.3	94	15.6			
More than 42 h/pw (More than 6 h/pd)	18	12.6	57	9.5			

Table 1: Cont.

	Probable ADHD				χ^2	df	p
	Present		Absent				
	n=143	19.2%	n=602	80.8%			
	n	%	n	%			
Gaming more than usual on weekends^c	89	62.2	277	46.0	12.171	1	<0.001
First gaming age					9.628	4	0.047
Before 6	50	35.0	154	25.6			
Between 7-12	72	50.3	358	59.5			
Between 13-17	19	13.3	65	10.8			
Between 18-25	2	1.4	10	1.7			
After 25	0	0.0	15	2.5			
Having problems related with gaming^e	67	46.9	147	24.4	28.406	1	<0.001
IGDS9-SF (Mean±SD)	22.78	8.45	15.72	6.43	t=9.379	182.917	<0.001
IGD according to IGDS9-SF cut-off^f	5	3.5	6	1.0	4.964	1	0.026
MOGQ (Mean±SD)							
Coping/Escape	20.53	7.57	15.85	7.27	t=6.864	743	<0.001
Recreation	11.69	3.28	10.24	3.90	t=4.572	247.038	<0.001
Fantasy	9.44	4.98	6.91	3.98	t=5.657	187.425	<0.001
Skill Development	10.33	5.03	9.06	4.88	t=2.778	743	0.006
Social	8.73	4.28	6.74	3.46	t=5.165	188.309	<0.001
Competition	11.71	4.99	9.86	4.83	t=4.100	743	<0.001

Odds Ratio (95% C.I.)=^a1.396 (1.039-1.875), ^b1.412 (1.007-1.982), ^c1.707 (1.257-2.318), ^d2.455 (1.831-3.291), ^e2.187 (1.641-2.916), ^f3.599 (1.083-11.963). h/pw: hour per week, h/pd: hour per day, ^gDuring last year, IGDS9-SF: Internet Gaming Disorder Scale- Short Form, MOGQ: Motives for Online Gaming Questionnaire

Scores of all six types of gaming motives were higher among those with probable ADHD, (Table 1). Among motives of online gaming; coping/escape (B=0.053, S.E.=0.019, Wald=7.473, df=1, p=0.006, OR [95% C.I.]=1.054 [1.015-1.095]), social (B=0.080, S.E.=0.034, Wald=5.541, df=1, p=0.019, OR [95% C.I.]=1.083 [1.013-1.158]), skill development (B=-0.100, S.E.=0.031, Wald=10.609, df=1, p=0.001, OR [95% C.I.]=0.905 [0.853-0.961]) and fantasy (B=0.067, S.E.=0.028, Wald=5.529, df=1, p=0.019, OR [95% C.I.]=1.069 [1.011-1.130]) distinguished the presence of probable ADHD (Nagelkerke R²=0.127).

Among the different game types, those with probable ADHD were mostly play MOBA, social network games, music games, MMORPGs, sports games/car games and horror-themed/survival games (Table 2). Logistic regression analysis was performed by taking the presence of probable ADHD as a dependent variable and game types as independent variables. In this analysis, playing only MMORPGs (B=-0.609, S.E.=0.193, Wald=9.897, df=1, p=0.002, OR [95% C.I.]=0.544 [0.372-0.795]) distinguished the presence of probable ADHD (Nagelkerke R²=0.021).

The frequency of MMORPG playing was correlated with the severity of IGD symptoms (r=0.326, p<0.001) and online gaming motives (ranged between r=0.156 [for Recreation] and r=0.341 [for Social]). The severity of IGD symptoms was correlated with online gaming motives (ranged between r=0.362 [for Recreation] and r=0.641 [for Coping/Escape]) (Table 3). Using the severity of IGD symptoms as dependent variables, the presence of probable ADHD and MMORPGs as fixed factors and online gaming motives as covariates, ANCOVA analysis was conducted. In this analysis, the probable ADHD and MMORPGs use as well as online gaming motives (coping/escape, recreation, fantasy, social, and competition) were associated with the severity of IGD symptoms, and also these effects involving probable ADHD, and the interaction of MMORPGs with each other (Table 4). We also compared the severity of IGD symptoms according to the four groups. Those with probable ADHD and using MMORPGs had the highest mean score (n=58, 27.22±7.11) for the severity of IGD symptoms than those with probable ADHD and not using MMORPGs (n=85, 19.75±7.97), those without probable ADHD and using MMORPGs

Table 2: Comparison of game genres according to the presence of probable ADHD

	Probable ADHD				χ^2	df	p
	Present		Absent				
	n=143	19.2%	n=602	80.8%			
	n	%	n	%			
- Social network games (e.g. Farm Ville, Mafia Wars) ^a	30	21.0	78	13.0	5.999	1	0.014
- Music games (e.g. Guitar Hero, Singstar) ^b	35	24.5	86	14.3	8.820	1	0.003
- RPG- role-playing game (e.g. Skyrim, Zelda, Mass Effect vs.) ^c	61	42.7	188	31.2	6.782	1	0.009
- MMORPG-Massively multiplayer online role-playing game (e.g. World of Warcraft, Lord of the Rings Online, The Secret World) ^d	58	40.6	163	27.1	10.068	1	0.002
- MOBA-Multiplayer online battle arena (e.g. LOL, Dota 2) ^e	77	53.8	262	43.5	4.967	1	0.026
- Sports games/car games (e.g. FIFA, NHL, Gran Turismo, Need for Speed) ^f	70	49.0	227	37.7	6.093	1	0.014
- Horror Themed/Survival Games (Resident Evil, Outlast) ^g	39	27.3	116	19.3	4.492	1	0.034

Odds Ratio (95% C.I.)=^a1.784 (1.117-2.847), ^b1.944 (1.247-3.032), ^c1.638 (1.128-2.380), ^d1.838 (1.258-2.685), ^e1.514 (1.050-2.183), ^f1.584 (1.098-2.286), ^g1.571 (1.032-2.391). Game genres that did not significantly differ are not shown on the Table; Battle Royale (e.g. Fortnite, PUBG, Apex), Action games/fighting games (e.g. Mount & Blade, Assassin's Creed, Uncharted, Tekken vs.), Puzzles or other small games (e.g. Scrabble, Okey, Gravity Pops, Candy crush, Solitaire, Tetris, Angry Birds), Social games (e.g. Second Life, Habbo Hotel, goSupermodel), Real time strategy games (e.g. Age of Empires, StarCraft), Turn based strategy games (e.g. Civilization), Platform games (e.g. Super Mario, Ratchet & Clank, Skylander), Simulator games (e.g. Flight simulator, Silent Hunter, Gran Turismo), First person shooting games - FPS (e.g. Call of Duty, Battlefield, Counterstrike) Third person shooting games - TPS (e.g. God of War, Metal Gear Solid, Just Cause) and the Sim's games (e.g. The Sims, Second Life)

Table 3: Correlations between daily times spent on MMORPG gaming last month, IGDS9-SF and online gaming motives

	Frequency of MMORPG*	IGDS9-SF**
	r	r
Online Gaming Motives		
Coping/Escape	0.285	0.641
Social	0.341	0.577
Fantasy	0.299	0.574
Skill development	0.249	0.487
Recreation	0.156	0.362
Competition	0.205	0.526
IGDS9-SF	0.326	-

*Spearman correlations, **Pearson correlations, all correlations are significant at the degree of $p < 0.001$, MMORPG: Massively multiplayer online role-playing game, IGDS9-SF: Internet Gaming Disorder Scale-Short Form

($n=163$, 18.29 ± 6.78), and those without probable ADHD and not using MMORPGs ($n=439$, 14.76 ± 6.03). In addition, the group with probable ADHD and not using MMORPGs and the group without probable ADHD and using MMORPGs had higher scores than those without probable ADHD and not using MMORPGs (Table 5).

DISCUSSION

The main finding of this research, consistent with the hypothesis, was that the presence of probable ADHD and the use of MMORPGs are both associated with the severity of disordered gaming, along with coping/escape, recreation, fantasy, social and competition gaming motives. This finding is in line with previous studies conducted in different samples and a This is the first study to evaluate the association of disordered gaming severity with both ADHD and MMORPGs together. We also examined the interaction of probable ADHD and MMORPGs effects that were significant. Finally, this is also the first study to evaluate the effects of gaming motives on the relationship between probable ADHD and disordered gaming. These gamers with probable ADHD may find the online gaming atmosphere appealing, possibly due to the lack of physical presence and anonymity, and therefore, may be more susceptible to IGD (76). ADHD appears to be associated with the loss of self-control, which is related to excessive online gaming; this can disturb the daily life of an individual (19,77) and make them even more vulnerable to IGD. The findings of this study may suggest that the enjoyment induced by gaming with MMORPGs (51) may provide immediate pleasure to

Table 4: Predictors of IGD symptom severity in ANCOVA analysis, where probable ADHD presence and playing the MMORPGs are fixed factors and motives for online gaming are covariates

Source	Type III sum of squares	df	Mean square	F	p	Partial eta squared
Covariates						
Coping/Escape	1447.067	1	1447.067	58.729	<0.001	0.074
Social	458.162	1	458.162	18.595	<0.001	0.025
Competition	695.228	1	695.228	28.216	<0.001	0.037
Skill development	3.050	1	3.050	0.124	0.725	<0.001
Fantasy	433.822	1	433.822	17.607	<0.001	0.023
Recreation	116.760	1	116.760	4.739	0.030	0.006
Fixed factors						
Probable ADHD	1770.477	1	1770.477	71.855	<0.001	0.089
MMORPG	536.430	1	536.430	21.771	<0.001	0.029
Interaction						
Probable ADHD *MMORPG	211.511	1	211.511	8.584	<0.003	0.012

a. R²=0.555 (Adjusted R²=0.550), MMORPG: Massively multiplayer online role-playing game (e.g. World of Warcraft, Lord of the Rings Online, The Secret World), IGD: Internet gaming disorder, ADHD: Attention deficit hyperactivity disorder

Table 5: Comparison of the severity of internet gaming disorder symptoms by groups

Groups	n	Mean	SD
1- ADHD- MMORPG-	439	14.76	6.03
2- ADHD- MMORPG+	163	18.29	6.78
3- ADHD+ MMORPG-	85	19.75	7.97
4- ADHD+ MMORPG+	58	27.22	7.11

SD: Standard deviation, ADHD: Attention deficit hyperactivity disorder, MMORPG: Massively multiplayer online role-playing game, Post-hoc (Tukey) analysis: 1<2, 3<4

young adults, particularly to those with probable ADHD. This may satisfy the needs of coping/escape, recreation, fantasy, social and competition motives, and may contribute to the loss of self-control in gamers with probable ADHD.

Although there is no “one size fits all” game suitable for all participants (51), gamers with probable ADHD seem to prefer MMORPGs more, which seems to increase their participation in more frequent gaming and put them at higher risk of IGD. In this study, the highest correlations between IGD symptoms and online play motives, both for daily time spent playing games with MMORPGs last month, were coping/escape and social motives. Disordered gamers tend to escape adverse emotional experiences in online games (78), as a maladaptive coping strategy, particularly when playing with MMORPG (79). As suggested for IGD (80) and ADHD (81), playing the MMORPG (82) is also suggested to be associated with

social anxiety. Park et al. (82) reported that the highest social anxiety was found in patients playing the MMORPG compared to other game genre, and that social anxiety score was positively correlated with IA score in the MMORPG group. Problematic gamers of MMORPG tend to have a socially anxious profile and may be attracted by the work-like roles and rules of this genre (61). Thus, the interaction of probable ADHD and MMORPGs effects on disordered gaming may be through social anxiety. Nevertheless, social anxiety was not evaluated in the present study, but should be considered in future studies.

King et al. (61) suggested that in complex, endless, socially-driven games, regardless of personality-level characteristics, disordered gaming may develop more readily and at more severe levels. Indeed, MMORPGs are computer RPGs in which thousands of gamers interact with each other in a persistent virtual world (41). Nevertheless, gamers who enjoy MMORPGs may be more vulnerable to IGD than gamers who play other game genres, as they had higher ADHD probability. MMORPGs may be associated with relief from dissatisfaction (i.e. escaping from real life problems) (37) and may serve as spaces for one to explore and develop one’s own identity (83). In this way, people with ADHD who often have relationship issues, problems with work or school etc. may find alternative life in MMORPGs to escape from real life, and ‘make the impossible possible’ by having a socialized persona they could never have in reality.

This may be similar to the self-medication theory suggested in substance use disorders. Thus, playing with MMORPGs may be to compensate for consequences of underlying problems such as ADHD that have not been properly treated. In this scenario, when gaming as a leisure activity becomes disordered gaming, it may cause problems itself, such as diminished academic performance and/or personal problems in managing relationships (43), which may lead to more gaming through maladaptive coping in the form of a vicious circle.

This study has some limitations to consider. First, the sample of the study was non-clinical, and all scales were self-rated. Unfortunately, the results of these self-rated scales do not replace a clinical diagnosis and may only indicate high-risk ADHD or IGD rather than diagnosis. This may limit the generalizability of these findings. Also, severe symptoms of ADHD may be related to poor cognitive function, making these findings less reliable as we used self-rated scales in this study. Second, probable ADHD might be more represented in the group of participants who did not fully complete the survey. Third, disordered gaming is predicted not only by higher time spent on gaming, but also by participation in a larger number of video game genres (84). Unfortunately, since our aim was to evaluate MMORPGs particularly, we did not evaluate the effect of multi-genre gaming. Finally, it is impossible to comment on the casual relationships among the primary constructs of interest because our study was cross-sectionally designed. Thus, the results of this study should be replicated with further prospective re-researches conducted in clinical samples with structured interviews.

Despite these limitations, the obtained results highlight the association between the severity of IGD symptoms with the presence of probable ADHD as well as MMORPGs, and also the interaction between them in young adults. Although all types of online gaming motives have significant effects on the severity of disordered gaming, coping/escape and social motives may have stronger effects in terms of the probable ADHD and MMORPG genres. Therefore, these variables should be investigated as potential risk factors for IGD and potential targets for treatment. This study may suggest that to better identify IGD among young adults, clinicians should assess the symptoms of ADHD, game genre preferences and online gaming motives, which are potentially important variables and should be considered in IGD intervention programs to reduce disordered gaming.

Contribution Categories		Author Initials
Category 1	Concept/Design	C.E., B.E., E.D.
	Data acquisition	M.T., N.K.
	Data analysis/Interpretation	C.E.
Category 2	Drafting manuscript	C.E., B.E., E.D.
	Critical revision of manuscript	C.E.
Category 3	Final approval and accountability	C.E., B.E., E.D., M.T., N.K.
Other	Technical or material support	N/A
	Supervision	N/A

Ethics Committee Approval: The protocol of the study was approved by the Ethical Committee of Cankaya University, Ankara, Turkey. (Date: 14.02.2019, Number: 80281877-605.01)

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