



Relationships of Internet addiction and Internet gaming disorder symptom severities with probable attention deficit/hyperactivity disorder, aggression and negative affect among university students

Cuneyt Evren¹ · Bilge Evren² · Ercan Dalbudak³ · Merve Topcu⁴ · Nilay Kutlu²

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Abstract

The aim of the present study was to evaluate relationships of Internet addiction (IA) and Internet gaming disorder (IGD) symptom severities with probable attention deficit/hyperactivity disorder (ADHD) and aggression among university students, while controlling the effects of anxiety and depressive symptoms. The study was conducted with online survey among 1509 volunteered university students in Ankara who regularly use the Internet, among whom we conducted analyses related with IA. Among these students, 987 of them, who play video games, were included in the analyses related with IGD. Correlation analyses revealed that the severities of the scale scores were mildly correlated with each other both among students who regularly use the Internet and students who play video games. Probable ADHD was associated with the severity of IA symptoms, together with depression and aggression, particularly physical aggression and hostility, in ANCOVA analyses. Similarly probable ADHD was also associated with the severity of IGD symptoms, together with depression and aggression, particularly physical aggression, anger and hostility, in ANCOVA analyses. These findings suggest that the presence of probable ADHD is related with both severity of IA and IGD symptoms, together with aggression and depression.

Keywords ADHD · Aggression · Depression · Hostility · Internet addiction · Internet gaming disorder · Physical aggression

Introduction

Internet addiction (IA) and internet gaming disorder (IGD)

Wide and increasing use of the Internet certainly made life easier; unfortunately maladaptive Internet use is related with some consequences such as the psychological problems, especially among young adults (Mazhari 2012). This

maladaptive Internet use has been frequently called as Internet addiction (IA), which can be defined as excessive, uncontrolled and harmful use of the Internet (Dalbudak et al. 2013). Nevertheless, it is still a controversial term, and consistent with this, it was not included in the Diagnostic and Statistical Manual of Mental Disorders: Fifth Edition (DSM-5) (American Psychiatric Association [APA] 2013). Among numerous activities on the Internet, including chatting, shopping, blogging, gambling and so on, gaming drew the main attention of the clinicians and investigators. Although playing video games is not considered intrinsically pathologic or problematic, gaming can become pathological for some players when the activity becomes dysfunctional, harming an individual's social, occupational, family, school and psychological functioning (Gentile et al. 2011). In general, "pathological gaming" can be described as persistent, recurrent and excessive involvement with computer or video games that cannot be controlled, despite associated problems (Griffiths 2005; Lemmens et al. 2009). Consistent with this, the DSM-5 included "Internet gaming disorder" (IGD) as a condition that needs further research before being fully recognized and accepted as an independent disorder in

✉ Cuneyt Evren
cuneytevren@yahoo.com; cuneytevren@hotmail.com

¹ Research, Treatment and Training Center for Alcohol and Substance Dependence (AMATEM), Bakirkoy Training and Research Hospital for Psychiatry Neurology and Neurosurgery, Istanbul, Turkey

² Department of Psychiatry, Baltalimani State Hospital for Muskuloskeletal Disorders, Istanbul, Turkey

³ Private Practice, Ankara, Turkey

⁴ Department of Psychology, Çankaya University, Ankara, Turkey

subsequent publications of the DSM (American Psychiatric Association [APA] 2013).

Attention deficit hyperactivity disorder (ADHD), IA and IGD

Attention deficit hyperactivity disorder (ADHD) is a childhood onset pervasive condition that continues with some robustness into adulthood in up to 60% of patients and characterized by inattention (IN) and/or hyperactivity/impulsivity (HI) (Faraone et al. 2006; Kessler et al. 2007; Mannuzza et al. 1993). Both a systematic review (Carli et al. 2013) and a meta-analysis (Ho et al. 2014) suggested an association between symptoms of ADHD and IA. Previous studies conducted among the Turkish university students (Dalbudak and Evren 2014; Dalbudak et al. 2015; Evren et al. 2018a; Kahraman and Demirci 2018) and among students in far East countries (Kim et al. 2016; Kitazawa et al. 2018) also suggested strong relationship between the severity of ADHD symptoms and the severity of IA symptoms even after controlling the effects of personality traits, depression and anxiety symptoms. Finally, other recent studies (Bielefeld et al. 2017; Kim et al. 2017; Leménager et al. 2018) supported the findings of these studies, and this strong association between IA and ADHD was suggested to be more significant for ADHD symptoms in young adults than that of childhood ADHD (Kim et al. 2017).

When specifically considering IGD, it has also been consistently associated with ADHD (Bioulac et al. 2008; Evren et al. 2019; Ha et al. 2006; Han et al. 2017; Weinstein et al. 2012). Also, a recent review suggested high correlations between IGD and ADHD, anxiety and depression (González-Bueso et al. 2018). Finally, Yen et al. (2017a) suggested that IGD is associated with ADHD among young adults, and that young adults with both IGD and ADHD have higher impulsivity and hostility, which mediate the association between ADHD and IGD.

Aggression, IA, IGD and ADHD

The relationship between aggression and IA among both adolescents (Ko et al. 2009a) and university students (Alavi et al. 2011) has been reported. Similarly, previous studies found a high association between aggressive behaviors and more frequent use of the computer and the Internet (Zboralski et al. 2009) or IA (Yen et al. 2007, 2008; Ko et al. 2009a; Kim 2013). Ko et al. (2009b) reported that although Internet use may reduce distress by providing immediate rewards and opportunities to engage in different activities, excessive use of the Internet is an important risk factor for aggression. Comparing male patients with IA and alcohol use disorder, Hwang et al. (2014) suggested that they share common characteristics that may lead to aggression and that

strategies to reduce aggression in patients with IA are necessary. Hahn and Kim (2014) suggested the possibility of common neurobiology between aggression and IA. A more recent study revealed a linear association between aggression and IA and suggested that anxiety and depression had partial or full mediating effects on the ability of aggression to predict IA (Lim et al. 2015).

Social learning theory, the cognitive neo-association model and social cognitions have all been utilized to explain this association between IA and aggression (Browne and Hamilton-Giachritsis 2005). These theories have mostly focused on how adolescents changed after they watched violent content in the media. Now, however, the development of modern technologies has made media not only able to be passively viewed by the users, but allow the users to actively participate in the activities, as in video games, for example (Ko et al. 2009a). Consistent with these, previous studies suggested a relationship between IGD and aggression among both adolescents (Ko et al. 2009a; Kim et al. 2018) and university students (Mehroof and Griffiths 2010). Also gamers who played for longer periods of time or gamers with IGD showed higher scores on aggression than did regular gamers (Lemmens et al. 2009; Grüsser et al. 2007; Kim et al. 2008; Mehroof and Griffiths 2010). Online gaming, communicational Internet use and playing first-person shooters were predictive of aggression and delinquency among adolescents (Holtz and Appel 2011). Finally, a follow-up study found that aggression contributes to a worse prognosis among those with IGD (Lee et al. 2018).

Previous research in adult ADHD samples has revealed higher self-reported trait anger and poorer anger control in ADHD patients compared to healthy controls (Lampe et al. 2007; Prada et al. 2014) and also compared to a control group with low ADHD symptoms (Ramirez et al. 1997). Dysfunctional anger expression (e.g., noisy arguing, physical aggression directed toward objects) was also reported to be significantly higher among those with ADHD (Ramirez et al. 1997). Bácskai et al. (2012) found higher severity of overall trait aggression, as well as physical and verbal aggression among patients with drug use disorder who screened positive for ADHD than patients who did not. Finally, studies conducted among adolescents suggested that impulsive aggression is a serious clinical and public health problem among those with ADHD (Saylor and Amann 2016) and those diagnosed with ADHD and comorbid disruptive behavior disorders report high levels of aggression (Bubbenzer-Busch et al. 2016; Harty et al. 2009).

The results of the study conducted by Yen et al. (2007) demonstrated that adolescents with IA had higher ADHD symptoms, depression and hostility. A more recent study of Yen et al. (2017a) suggested that IGD is associated with ADHD among young adults and mediators of this association are impulsivity and hostility. Consistent with these, a

previous study suggested that young adults with combined-type ADHD and more severe IA were more likely to be cyberbullying perpetrators (Yen et al. 2014). Finally, it was suggested that the emotional regulation strategies that characterize those with IGD could be contributing factors to the depression and hostility tendencies of these people (Yen et al. 2017b).

Negative affect and the primary constructs of interest

Previous studies suggested that depressive and anxiety symptoms are important factors to evaluate when considering IA (Dalbudak et al. 2013; Ho et al. 2014) or IGD (González-Bueso et al. 2018; Liu et al. 2018). Similarly, ADHD (Dalbudak and Evren 2014) and aggression (Lim et al. 2015) are associated with negative affect. These symptoms of negative affect may also have partial or full mediating effects on the ability of aggression (Lim et al. 2015) or ADHD (Evren et al. 2018a) to predict IA.

Study hypothesis and objectives

Although there are some studies that evaluated the relationship of ADHD with severity of IA or IGD symptoms, this is the first study to evaluate these relationships in the same population and to control other variables that are related with both of these variables such as aggression, depression and anxiety while evaluating these relationships. We hypothesized that the presence of probable ADHD may still be related with severity of IA and IGD even after controlling these variables. We also wanted to evaluate particular dimensions of aggression that may be related with IA and IGD.

Methods

Subjects and procedure

The present study was conducted with cross-sectional online self-report survey among volunteered university students in Ankara. A Web site was prepared for online participation. Approval from the Ethical Committee of the Canakaya University was taken. The institutional review board approval date was April 12, 2018, and the number was 80281877-050.99.

The students were asked to fill out the form on the website anonymously. Informed consent was approved by students online before continuing with further questions. Exclusion criteria were unfilled forms. For controlling the duplicate data entry, we checked the e-mail addresses and the

nicknames and we also checked for Internet Protocol (IP) Address of the participants.

The study was conducted among 1509 volunteered university students (670 were male [44.4%] and 839 were female [55.6%]) in Ankara who regularly use the Internet, among whom the analyses related with IA were conducted. Among these 1509 volunteered university students, 987 reported that they play video games (567 were male [57.4%] and 420 were female [42.6%]) and were included in the analyses related with IGD.

Measures

Internet Addiction Scale (IAS)

IAS was developed by Nichols and Nicki (2004) to measure the severity of IA and tested on a group of 233 college students. Cronbach's α of the IAS was 0.95, and the explained variance was 46.50%. The IAS is scored by summing the Likert responses across the 31 items. In a reliability and validity study of the Turkish version of the IAS, Cronbach's α value was 0.93 in 253 university students (Kayri and Gunuc 2009). In the present study, Cronbach's α was 0.92.

Internet Gaming Disorder Scale–Short Form (IGDS9-SF)

The IGDS9-SF assesses the symptoms and severity of IGD and its detrimental effects by examining both online and/or offline gaming activities occurring over a 12-month period (Pontes and Griffiths 2015). The scale comprises nine items corresponding to the nine core criteria defined by the DSM-5. They are answered on a five-point Likert scale ranging from (1) never to (5) very often and high scores on the scale translate onto higher level of gaming disorder. In the present study, Turkish version of the IGDS9-SF was used (Evren et al. 2018b).

Adult ADHD Self-Report Scales (ASRS-v1.1)

The ASRS (Kessler et al. 2005a, b) is an 18-item scale that measures ADHD symptoms based on DSM Fourth Edition (DSM-IV-TR) criteria (American Psychiatric Association, 2000). The Turkish version of ASRS has demonstrated good reliability and validity in university students (Dogan et al. 2009). Developed under the auspices of the World Health Organization, ASRS is also a short six-item screening instrument, the questions in which were extracted, using stepwise logistic regression, from a larger survey of 18 questions comprising the Adult Self-Report Survey that taps the 18 specific "Criterion A" symptoms defining the disorder in DSM-IV. The ASRS 6-item screen was developed for community-based studies and exhibits strong concordance with clinician diagnoses as well as sound psychometric properties

(Chamberlain et al. 2017; Kessler et al. 2005b, 2006). The 5-point Likert-type scale ranges from “0” (never) to “4” (very often). Each response of sometimes or greater (2 or more) on screening items 1–3 equated to 1 point; each response of ten or greater (3 or more) on screening items 4–6 resulted in a point. A total score of 4 or more indicated probable ADHD. We therefore used this recommended definition to identify highly likely ADHD cases in our sample and named as “probable ADHD.” Nevertheless, the result of the test does not replace a clinical diagnosis and the clinician must take false positives into consideration by evaluating the ASRS positives with gold standard scales.

Buss–Perry Aggression Questionnaire (AQ)

Trait aggression was measured by the total score of the AQ and scores of the subscales including physical aggression (PA, nine items), verbal aggression (VA, five items), anger (AN, seven items) and hostility (HS, eight items) (Buss and Perry 1992). The AQ comprises 29 items of a 5-point Likert format from one (“extremely uncharacteristic of me”) to five (“extremely characteristic of me”). Evidence for the scale’s construct validity is available elsewhere (Buss and Perry 1992). The Turkish version of the AQ, which was used in the present study, has been found to be valid and reliable (Evren et al. 2011).

90-Item Symptom Checklist—Revised

SCL-90-R is a self-report measure used to assess psychopathologic symptoms (Derogatis 1983). It has 90 items rated with a 5-point Likert scale (1, no problem to 5, very serious) to assess the extent to which individuals have experienced the listed symptoms in the last 7 days. These 90 items were grouped into nine subscales, although we only used depression and anxiety subscales, which were relevant with the scope of the present study. It was suggested that the higher the scores on the subscales are, the higher the psychological distress that the individual has experienced. In the present study, the Turkish version of SCL-90-R was used (Dag 1991).

Data analysis

The statistical package SPSS 17.0 for Windows (SPSS, 278 Chicago, IL, USA) was used for all the analyses. Frequencies and percentages were given for sociodemographic variables, whereas means and standard deviations were given for age and scale scores. Pearson correlation analyses were conducted between scale scores both among those who use the Internet regularly ($n = 1509$) and among those who play video games ($n = 987$). Taking severity of IA symptoms as dependent variable, probable ADHD as a fixed factor and

severity of aggression (dimensions of aggression in second ANCOVA), depression and anxiety as covariates, ANCOVA analyses were conducted among those who use the Internet regularly ($n = 1509$). Also taking severity of IGD symptoms as dependent variable, probable ADHD as a fixed factor and severity of aggression (dimensions of aggression in second ANCOVA), depression and anxiety as covariates, ANCOVA analyses were conducted among those who play video games ($n = 987$). For all statistical analyses, p values were two-tailed, and differences were considered significant at $p < 0.05$.

Results

Age, gender and means of scale scores are shown for both among students who use the Internet regularly ($n = 1509$) and among students who play video games ($n = 987$) in Table 1. Correlation analyses revealed that the severities of the scale scores were mildly correlated with each other among both students who use the Internet regularly and students who play video games (Table 2). Probable ADHD was associated with the severity of IA symptoms, together with depression and aggression, particularly physical aggression and hostility dimensions of aggression, in ANCOVA analyses (Table 3). Similarly probable ADHD was associated also with the severity of IGD symptoms, together with depression and aggression, particularly physical aggression, anger and

Table 1 Sociodemographic variables and scale scores

	Internet users $n = 1509$		Video game players $n = 987$	
	Mean	S.D.	Mean	S.D.
Age	24.05	6.93	23.65	6.37
Gender (n , %)				
Male	670	44.4	567	57.4
Female	839	55.6	420	42.6
Probable ADHD	258	17.1	166	16.8
BPAQ	43.84	17.82	46.05	18.00
Physical aggression	11.01	6.75	12.10	6.92
Verbal aggression	8.85	4.08	9.13	4.04
Anger	11.95	5.25	12.32	5.33
Hostility	12.03	6.56	12.51	6.60
Depression	18.93	10.83	18.85	11.05
Anxiety	10.18	8.52	10.34	7.23
IAS	70.03	19.99	72.28	20.11
IGDS9-SF	–	–	18.08	7.23

ADHD attention deficit/hyperactivity disorder, BPAQ Buss–Perry Aggression Questionnaire, IAS Internet Addiction Scale, IGDS9-SF: Internet Gaming Disorder Scale—Short Form

Table 2 Correlations between scale scores

	Internet users (<i>n</i> = 1509)			Video game players (<i>n</i> = 987)		
	IAS	Depression	Anxiety	IGDS9-SF	Depression	Anxiety
Internet Addiction Scale	–	0.365	0.353	0.73	–	–
IGDS9-SF	0.73	–	–	–	0.330	0.323
BPAQ	0.347	0.403	0.485	0.318	0.411	0.495
Physical aggression	0.248	0.210	0.327	0.273	0.215	0.337
Verbal aggression	0.144	0.072*	0.156	0.119	0.077*	0.149
Anger	0.285	0.362	0.441	0.216	0.366	0.446
Hostility	0.371	0.545	0.533	0.333	0.553	0.545

IAS Internet Addiction Scale, IGDS9-SF Internet Gaming Disorder Scale—Short Form, BPAQ Buss–Perry Aggression Questionnaire

* $p < 0.05$, rest is $p < 0.001$

Table 3 Predictors of the Internet addiction symptom severity in ANCOVA (*n* = 1509)

Source	Type III sum of squares	<i>df</i>	<i>F</i>	<i>p</i>
<i>Covariates^a</i>				
BPAQ	18,196.369	1	59.054	<0.001
Depression	7274.497	1	23.609	<0.001
Anxiety	1315.601	1	4.270	0.039
<i>Fixed factor</i>				
Probable ADHD	27,888.237	1	90.508	<0.001
<i>Covariates^b</i>				
Physical aggression	1977.459	1	6.461	0.011
Verbal aggression	0.031	1	0.000	0.992
Anger	136.662	1	0.446	0.504
Hostility	9429.369	1	30.807	<0.001
Depression	4034.972	1	13.183	<0.001
Anxiety	1153.848	1	3.770	0.052
<i>Fixed factor</i>				
Probable ADHD	28,736.231	1	93.884	<0.001

BPAQ Buss–Perry Aggression Questionnaire, ADHD attention deficit/hyperactivity disorder

^a $R^2 = 0.231$ (adjusted $R^2 = 0.229$)

^b $R^2 = 0.238$ (adjusted $R^2 = 0.234$)

hostility dimensions of aggression, in ANCOVA analyses (Table 4).

Discussion

The main finding of the present study, which is also consistent with our hypothesis, was that the presence of probable ADHD was still related with the severities of IA and IGD even after controlling for variables such as aggression and negative affect. Consistent with this, Bielefeld et al. (2017) suggested that ADHD and IA share psychopathological features and clinicians should be aware of the close

Table 4 Predictors of the Internet gaming disorder symptom severity in ANCOVA (*n* = 987)

Source	Type III sum of squares	<i>df</i>	<i>F</i>	<i>p</i>
<i>Covariates^a</i>				
BPAQ	1249.847	1	29.538	<0.001
Depression	475.135	1	11.229	0.001
Anxiety	81.123	1	1.917	0.166
<i>Fixed factor</i>				
Probable ADHD	2202.197	1	52.045	<0.001
<i>Covariates^b</i>				
Physical aggression	925.342	1	22.303	<0.001
Verbal aggression	3.565	1	0.086	0.769
Anger	222.220	1	5.356	0.021
Hostility	742.013	1	17.885	<0.001
Depression	329.746	1	7.948	0.005
Anxiety	68.502	1	1.651	0.199
<i>Fixed factor</i>				
Probable ADHD	2229.721	1	53.742	<0.001

BPAQ Buss–Perry Aggression Questionnaire, ADHD attention deficit/hyperactivity disorder

^a $R^2 = 0.194$ (adjusted $R^2 = 0.191$)

^b $R^2 = 0.213$ (adjusted $R^2 = 0.207$)

relationships between the two disorders both diagnostically and therapeutically. Among dimensions of aggression, hostility and physical aggression predicted the severity of IA, and additional to hostility and physical aggression, anger also predicted the severity of IGD. This may suggest that young adults with high risk of probable ADHD, who have also hostility feelings, anger, physical aggression and negative affect, may enjoy using the Internet or gaming, which both may offer them immediate pleasure to regulate these negative emotions. Early speculation by Young (1998) suggested that Internet use has a propensity to alleviate dysphoric moods and may therefore be used to cope with real-life problems. Later studies demonstrated significant

associations between using the Internet to manage emotions, difficulty regulating Internet use and negative outcomes of Internet use (Caplan 2002; Evren et al. 2018a; Gámez-Guadix 2014; LaRose et al. 2003; Yen et al. 2017b). Thus, results of the present study may suggest that aggressive young adults with probable ADHD and negative affect may be especially vulnerable to both IA and IGD. These young adults may be using the Internet or gaming as a mean of coping with anger or hostility, and the Internet or gaming may provide legal platform for physical aggression. The anonymous environment of the cyber world may lead to the psychological effect termed the “online disinhibition effect” (Kim 2013). Vice versa may also be possible; exposure to Internet content or video games that is violent may be causal risk factor for increased aggressive affect, aggressive cognition and aggressive behavior (Anderson and Bushman 2002; Anderson et al. 2010; Barlett et al. 2007). In some activities such as online gaming, aggressive behavior is rewarded by increased scores in gaming, becomes a goal directed behavior and is trained repeatedly (Ko et al. 2009a). Thus, frequently rehearsed aggressive script will increase the accessible strength of violent behavior (Huesmann 2007). Nevertheless, in contrast with these, a recent study that investigated the effects of long-term violent video gameplay provided strong evidence against the frequently debated negative effects of playing violent video games in adults (Kühn et al. 2018). As a result, the relationships between the primary constructs of interest can be bidirectional. Unfortunately, because of the cross-sectional design, it was not possible to make conclusive statements about the temporal order between the primary constructs of interest.

Internet, which provides many different activities for the user, including gaming, is characterized by rapid response, immediate reward, which may reduce the feelings of boredom or aversion to delayed reward in students with probable ADHD. Internet and gaming can also provide an unreal life for these students, in which they can live their fantasies without inhibition. Lack of self-control may make it difficult for these students to control their Internet use and/or gaming, making them vulnerable to IA and/or IGD. Previous studies suggested that probable ADHD is associated with the presence and the severity of both IA (Dalbudak and Evren 2014; Evren et al. 2018a; Ho et al. 2014; Kahraman and Demirci 2018; Kitazawa et al. 2018) and IGD (Evren et al. 2019; González-Bueso et al. 2018; Han et al. 2017; Weinstein et al. 2012; Yen et al. 2017a). Consistent with these, in the present study, significant associations have been found between the presence of probable ADHD and severities of both IA and IGD symptoms. Additional to probable ADHD, aggression (particularly hostility and physical aggression) and negative affect were also associated with severities of both IA and IGD symptoms. This is also consistent with previous studies that found association of ADHD, depression and hostility

with IA among adolescents (Yen et al. 2007) and with IGD among young adults (Yen et al. 2017a, b).

Buss and Perry (1992) suggested anger was the affective component that bridges the cognitive component of hostility and the instrumental components of verbal and physical aggression. Hostility is a psychiatric symptom reflected during unfriendly cognition, affect and behavior (Yen et al. 2017a, b). Subjects with IA have been reported to have higher hostility (Shapira et al. 2003; te Wildt et al. 2007; Yen et al. 2008, 2011), and hostility has also been reported to predict the persistence and emergence of IA in two prospective studies (Ko et al. 2007, 2009b). After subjects become addicted to the Internet, significantly higher score was observed for hostility, suggesting that this was outcome of IA (Dong et al. 2011). Hostility is also related with IGD (Choo et al. 2010). Violent games have immediate priming, excitation and imitation effects and long-term observational learning, role-playing and desensitization effects (Huesmann and Taylor 2006); these can contribute to higher hostility among individuals with IGD (Yen et al. 2017a, b). Subjects using the Internet mainly for online gaming had higher expressive hostility behavior not only in the real world but also online (Yen et al. 2011). The results of the previous study suggest that people with more physical-aggressive personality engage in a more aggressive style of playing (Peng et al. 2008). Yu (2016) reported that the severity of IGD symptoms showed significant positive correlation with physical aggression. Another study of Yu and Cho (2016) revealed that the group with IGD had the highest mean score of physical aggression, anxiety and depression than did the other types of gamer groups. Also IGD was positively associated with physical aggression. In the violent Internet gaming world, hostility can be expressed and violence perpetrated without restriction; this provides a space in which adults with significant hostility can express their physical aggression in a manner probably prohibited in the real world (Yen et al. 2017a, b). However, the causal relationships between hostility or physical aggression and IGD should be confirmed in a prospective study.

There are several limitations that should be noted. First of all, participants were non-clinical samples and all scales were self-rated, which may only show high risk ADHD rather than the diagnosis. Secondly, we did not gain more information for sociodemographic characters of the participants. Thirdly, since this study is cross-sectional, the findings of this study cannot address the causal relationships among the primary constructs of interest.

But at least these findings demonstrate that the presence of probable ADHD was associated with the severities of IA and IGD even after controlling the effect of aggression, depression and anxiety symptoms among Turkish young adults, suggesting that these are each important consideration in understanding the pathophysiology of the relationship

between ADHD and both IA and IGD. The present study may suggest that to better understand IA and IGD among university students, clinicians must carefully evaluate ADHD symptoms, depression and aggression, which are potentially important components to be considered in IA and IGD intervention programs and potential treatment targets for reducing IA and IGD.

References

- Alavi SS, Maracy MR, Jannatifard F et al (2011) The effect of psychiatric symptoms on the internet addiction disorder in Isfahan's University students. *J Res Med Sci* 16:793–800
- American Psychiatric Association (2000) Diagnostic and statistical manual of mental disorders: fourth edition (DSM-IV-TR). American Psychiatric Press, Washington
- American Psychiatric Association (2013) Diagnostic and statistical manual of mental disorders, 5th edn. American Psychiatric Publishing, Arlington
- Anderson CA, Bushman BJ (2002) Human aggression. *Annu Rev Psychol* 53:27–51
- Anderson CA, Shibuya A, Ihori N et al (2010) Violent video game effects on aggression, empathy, and prosocial behavior in eastern and western countries: a meta-analytic review. *Psychol Bull* 136:151–173
- Bácskai E, Czobor P, Gerevich J (2012) Trait aggression, depression and suicidal behavior in drug dependent patients with and without ADHD symptoms. *Psychiatry Res* 200:719–723
- Barlett CP, Harris RJ, Baldassaro R (2007) Longer you play, the more hostile you feel: examination of first person shooter video games and aggression during video game play. *Aggress Behav* 33:486–497
- Bielefeld M, Drews M, Putzig I et al (2017) Comorbidity of Internet use disorder and attention deficit hyperactivity disorder: two adult case-control studies. *J Behav Addict* 6:490–504
- Bioulac S, Arfi L, Bouvard MP (2008) Attention deficit/hyperactivity disorder and video games: a comparative study of hyperactive and control children. *Eur Psychiatr* 23:134–141
- Browne KD, Hamilton-Giachritsis C (2005) The influence of violent media on children and adolescents: a public-health approach. *Lancet* 365:702–710
- Bubbenzer-Busch S, Herpertz-Dahlmann B, Kuzmanovic B et al (2016) Neural correlates of reactive aggression in children with attention-deficit/hyperactivity disorder and comorbid disruptive behaviour disorders. *Acta Psychiatr Scand* 133:310–323
- Buss AH, Perry M (1992) The aggression questionnaire. *J Pers Soc Psychol* 63:452–459
- Caplan SE (2002) Problematic Internet use and psycho-social wellbeing: development of a theory based cognitive-behavioral measurement instrument. *Comput Human Behav* 18:553–575
- Carli V, Durkee T, Wasserman D et al (2013) The association between pathological Internet use and comorbid psychopathology: a systematic review. *Psychopathology* 46:1–13
- Chamberlain SR, Ioannidis K, Leppink EW, Niaz F, Redden SA, Grant JE (2017) ADHD symptoms in non-treatment seeking young adults: relationship with other forms of impulsivity. *CNS Spectr* 22:22–30
- Choo H, Gentile DA, Sim T et al (2010) Pathological video gaming among Singaporean youth. *Ann Acad Med Singapore* 39:822–829
- Dag I (1991) Reliability and validity of Symptom Check List-90-Revised among university students. *Turk Psikiyatri Derg* 2:5–12
- Dalbudak E, Evren C (2014) The relationship of Internet addiction severity with attention deficit hyperactivity disorder symptoms in Turkish university students; impact of personality traits, depression and anxiety. *Compr Psychiatry* 55:497–503
- Dalbudak E, Evren C, Aldemir S et al (2013) Relationship of internet addiction severity with depression, anxiety, and alexithymia, temperament and character in university students. *Cyberpsychol Behav Soc Netw* 16:272–278
- Dalbudak E, Evren C, Aldemir S et al (2015) The impact of sensation seeking on the relationship between attention deficit/hyperactivity symptoms and severity of Internet addiction risk. *Psychiatry Res* 228:156–161
- Derogatis LR (1983) SCL-90. Administration, Scoring and Procedure Manual-II for the revised version. Clinical Psychometric Research, Towson
- Dogan S, Oncu B, Varol-Saracoglu G et al (2009) Validity and reliability of the Turkish version of the Adult ADHD Self-Report Scale (ASRS-v1.1). *Anatol J Psychiatry* 10:77–87
- Dong G, Lu Q, Zhou H et al (2011) Precursor or sequela: pathological disorders in people with Internet addiction disorder. *PLoS ONE* 6:e14703
- Evren C, Cinar O, Celik S et al (2011) Reliability and validity of Turkish Version the Buss-Perry's Aggression Questionnaire in male alcohol dependent inpatients. *Dusunen Adam J Psychiatry Neurol Sci* 24:283–295
- Evren C, Dalbudak E, Topcu M et al (2018a) Psychometric validation of the Turkish nine-item Internet Gaming Disorder Scale-Short Form (IGDS9-SF). *Psychiatry Res* 265:349–354
- Evren B, Evren C, Dalbudak E et al (2018b) Relationship of internet addiction severity with probable ADHD and difficulties in emotion regulation among young adults. *Psychiatry Res* 269:494–500
- Evren B, Evren C, Dalbudak E et al (2019) Neuroticism and introversion mediates the relationship between probable ADHD and symptoms of Internet gaming disorder: results of an online survey. *Psychiatry Clin Psychopharmacol* 1:2. <https://doi.org/10.1080/24750573.2018.1490095>
- Faraone SV, Biederman J, Mick E (2006) The age-dependent decline of attention deficit hyperactivity disorder: a meta-analysis of follow-up studies. *Psychol Med* 36:159–165
- Gámez-Guadix M (2014) Depressive symptoms and problematic internet use among adolescents: analysis of the longitudinal relationships from the cognitive-behavioral model. *Cyberpsychol Behav Soc Netw* 17:714–719
- Gentile DA, Choo H, Liau A et al (2011) Pathological video game use among youths: a two-year longitudinal study. *Pediatrics* 127:319–329
- González-Bueso V, Santamaría JJ, Fernández D et al (2018) Association between Internet gaming disorder or pathological video-game use and comorbid psychopathology: a comprehensive review. *Int J Environ Res Public Health* 15(4):688
- Griffiths M (2005) A “components” model of addiction within a biopsychosocial framework. *J Subst Use* 10:191–197
- Grüsser SM, Tahleemann R, Griffiths MD (2007) Excessive computer game playing: evidence for addiction and aggression? *Cyberpsychol Behav* 10:290–292
- Ha JH, Yoo HJ, Cho IH et al (2006) Psychiatric comorbidity assessed in Korean children and adolescents who screen positive for Internet addiction. *J Clin Psychiatr* 67:821–826
- Hahn C, Kim DJ (2014) Is there a shared neurobiology between aggression and Internet addiction disorder? *J Behav Addict* 3:12–20
- Han DH, Kim SM, Bae S et al (2017) Brain connectivity and psychiatric comorbidity in adolescents with Internet gaming disorder. *Addict Biol* 22:802–812
- Harty SC, Miller CJ, Newcorn JH et al (2009) Adolescents with childhood ADHD and comorbid disruptive behavior disorders: aggression, anger, and hostility. *Child Psychiatry Hum Dev* 40:85–97

- Ho RC, Zhang MW, Tsang TY et al (2014) The association between internet addiction and psychiatric co-morbidity: a meta-analysis. *BMC Psychiatry* 14:183
- Holtz P, Appel M (2011) Internet use and video gaming predict problem behavior in early adolescence. *J Adolesc* 34:49–58
- Huesmann LR (2007) The impact of electronic media violence: scientific theory and research. *J Adolesc Health* 41:6–13
- Huesmann LR, Taylor LD (2006) The role of media violence in violent behavior. *Annu Rev Public Health* 27:393–415
- Hwang JY, Choi JS, Gwak AR et al (2014) Shared psychological characteristics that are linked to aggression between patients with Internet addiction and those with alcohol dependence. *Ann Gen Psychiatry* 13:6
- Kahraman Ö, Demirci EÖ (2018) Internet addiction and attention-deficit-hyperactivity disorder: effects of anxiety, depression and self-esteem. *Pediatr Int* 60:529–534
- Kayri M, Gunuc S (2009) The adaptation of internet addiction scale into Turkish: the study of validity and reliability. *AU J Fac Educ Sci* 42:157–175
- Kessler RC, Adler L, Ames M et al (2005a) The World Health Organization adult ADHD self-report scale (ASRS): a short screening scale for use in the general population. *Psychol Med* 35:245–256
- Kessler RC, Chiu WT, Demler O (2005b) Prevalence, severity, and comorbidity of 12-month DSM-IV disorders in the National Comorbidity Survey Replication. *Arch Gen Psychiatry* 62:617–627
- Kessler RC, Adler L, Barkley R et al (2006) The prevalence and correlates of adult ADHD in the United States: results from the National Comorbidity Survey Replication. *Am J Psychiatry* 163:716–723
- Kessler RC, Adler LA, Gruber MJ et al (2007) Validity of the World Health Organization Adult ADHD Self-Report Scale (ASRS) screener in a representative sample of health plan members. *Int J Methods Psychiatr Res* 16:52–65
- Kim K (2013) Association between Internet overuse and aggression in Korean adolescents. *Pediatr Int* 55:703–709
- Kim EJ, Namkoong K, Ku T et al (2008) The relationship between online game addiction and aggression, self-control and narcissistic personality traits. *Eur Psychiatry* 23:212–218
- Kim BS, Chang SM, Park JE et al (2016) Prevalence, correlates, psychiatric comorbidities, and suicidality in a community population with problematic Internet use. *Psychiatry Res* 244:249–256
- Kim D, Lee D, Lee J et al (2017) Association between childhood and adult attention deficit hyperactivity disorder symptoms in Korean young adults with Internet addiction. *J Behav Addict* 6:345–353
- Kim E, Yim HW, Jeong H et al (2018) The association between aggression and risk of Internet gaming disorder in Korean adolescents: the mediation effect of father-adolescent communication style. *Epidemiol Health* 40:e2018039
- Kitazawa M, Yoshimura M, Murata M et al (2018) Associations between problematic Internet use and psychiatric symptoms among university students in Japan. *Psychiatry Clin Neurosci* 72:531–539
- Ko CH, Yen JY, Yen CF et al (2007) Factors predictive for incidence and remission of Internet addiction in young adolescents: a prospective study. *Cyberpsychol Behav* 10:545–551
- Ko CH, Yen JY, Chen CS et al (2009a) Predictive values of psychiatric symptoms for Internet addiction in adolescents: a 2-year prospective study. *Arch Pediatr Adolesc Med* 163:937–943
- Ko CH, Yen JY, Liu SC et al (2009b) The associations between aggressive behaviors and Internet addiction and online activities in adolescents. *J Adolesc Health* 44:598–605
- Kühn S, Kugler DT, Schmalen K et al (2018) Does playing violent video games cause aggression? A longitudinal intervention study. *Mol Psychiatry*. <https://doi.org/10.1038/s41380-018-0031-7>
- Lampe K, Konrad K, Kroener S et al (2007) Neuropsychological and behavioural disinhibition in adult ADHD compared to borderline personality disorder. *Psychol Med* 37:1717–1729
- LaRose R, Lin CA, Eastin MS (2003) Unregulated Internet usage: addiction, habit, or deficient self-regulation? *Media Psychol* 5:225–253
- Lee SY, Lee HK, Bang SY et al (2018) Aggression and harm-avoidant trait impede recovery from internet gaming disorder. *Front Psychiatry* 9:263
- Leménager T, Hoffmann S, Dieter J et al (2018) The links between healthy, problematic, and addicted Internet use regarding comorbidities and self-concept-related characteristics. *J Behav Addict* 7:31–43
- Lemmens JS, Valkenburg P, Peter J (2009) Development and validation of a game addiction scale for adolescents. *Media Psychol* 12:77–95
- Lim JA, Gwak AR, Park SM et al (2015) Are adolescents with internet addiction prone to aggressive behavior? The mediating effect of clinical comorbidities on the predictability of aggression in adolescents with internet addiction. *Cyberpsychol Behav Soc Netw* 18:260–267
- Liu L, Yao YW, Li CR et al (2018) The comorbidity between Internet gaming disorder and depression: interrelationship and neural mechanisms. *Front Psychiatry* 9:154
- Mannuzza S, Klein RG, Bessler A et al (1993) Adult outcome of hyperactive boys. Educational achievement, occupational rank, and psychiatric status. *Arch Gen Psychiatry* 50:565–576
- Mazhari S (2012) Association between problematic internet use and impulse control disorders among Iranian university students. *Cyberpsychol Behav Soc Netw* 15:270–273
- Mehroof M, Griffiths MD (2010) Online gaming addiction: the role of sensation seeking, self-control, neuroticism, aggression, state anxiety, and trait anxiety. *Cyberpsychol Behav Soc Netw* 13:313–316
- Nichols LA, Nicki R (2004) Development of a psychometrically sound internet addiction scale: a preliminary step. *Psychol Addict Behav* 18:381–384
- Peng W, Liu M, Mou Y (2008) Do aggressive people play violent computer games in a more aggressive way? Individual difference and idiosyncratic game-playing experience. *Cyberpsychol Behav* 11:157–161
- Pontes HM, Griffiths MD (2015) Measuring DSM-5 Internet gaming disorder: development and validation of a short psychometric scale. *Comput Human Behav* 45:137–143
- Prada P, Hasler R, Baud P et al (2014) Distinguishing borderline personality disorder from adult attention deficit/hyperactivity disorder: a clinical and dimensional perspective. *Psychiatry Res* 217:107–114
- Ramirez CA, Rosén LA, Deffenbacher JL et al (1997) Anger and anger expression in adults with high ADHD symptoms. *J Atten Disord* 2:115–128
- Saylor KE, Amann BH (2016) Impulsive aggression as a comorbidity of attention-deficit/hyperactivity disorder in children and adolescents. *J Child Adolesc Psychopharmacol* 26:19–25
- Shapira NA, Lessig MC, Goldsmith TD et al (2003) Problematic Internet use: proposed classification and diagnostic criteria. *Depress Anxiety* 17:207–216
- te Wildt BT, Putzig I, Zedler M et al (2007) Internet dependency as a symptom of depressive mood disorders. *Psychiatr Prax* 34(Suppl 3):318–322 (German)
- Weinstein A, Weizman A (2012) Emerging association between addictive gaming and attention-deficit/hyperactivity disorder. *Curr Psychiatr Rep* 14:590–597
- Yen JY, Ko CH, Yen CF et al (2007) The comorbid psychiatric symptoms of Internet addiction: attention deficit and hyperactivity disorder (ADHD), depression, social phobia, and hostility. *J Adolesc Health* 41:93–98

- Yen JY, Ko CH, Yen CF et al (2008) Psychiatric symptoms in adolescents with Internet addiction: comparison with substance use. *Psychiatry Clin Neurosci* 62:9–16
- Yen JY, Yen CF, Wu HY et al (2011) Hostility in the real world and online: the effect of Internet addiction, depression, and online activity. *Cyberpsychol Behav Soc Netw* 14:649–655
- Yen CF, Chou WJ, Liu TL et al (2014) Cyberbullying among male adolescents with attention-deficit/hyperactivity disorder: prevalence, correlates, and association with poor mental health status. *Res Dev Disabil* 35:3543–3553
- Yen JY, Liu TL, Wang PW et al (2017a) Association between Internet gaming disorder and adult attention deficit and hyperactivity disorder and their correlates: impulsivity and hostility. *Addict Behav* 64:308–313
- Yen JY, Yeh YC, Wang PW et al (2017b) Emotional regulation in young adults with Internet gaming disorder. *Int J Environ Res Public Health* 15(1):30
- Yu H (2016) Development of an Internet gaming disorder scale based on the DSM-5's nine diagnostic criteria with South Korean gamer samples. In: Lex P, Lee A (eds) *Transnational contexts of development history, sociality, and society of play: video games in East Asia*. Palgrave Macmillan, New York, pp 211–236
- Yu H, Cho J (2016) Prevalence of Internet gaming disorder among Korean adolescents and associations with non-psychotic psychological symptoms, and physical aggression. *Am J Health Behav* 40:705–716
- Zboralski K, Orzechowska A, Talarowska M et al (2009) The prevalence of computer and Internet addiction among pupils. *Postepy Hig Med Dosw (Online)* 63:8–12

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