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Internet addiction and attention-deficit / hyperactivity disorder symptoms in adolescents with autism spectrum disorder

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ABSTRACT

Aim: Several studies have reported that internet addiction (IA) is more prevalent in adolescents with autism spectrum disorder (ASD). However, the characteristics of ASD adolescents with IA are unclear. The objective of this study was to investigate the prevalence of IA in ASD adolescents, and compare the characteristics between the IA and the non-IA groups in adolescents with ASD.

Methods: The study included 55 participants who were outpatients at Ehime University Hospital and Ehime Rehabilitation Center for Children in Japan, aged 10–19 years, diagnosed with ASD. Patients and their parents answered several questionnaires including the Young's Internet Addiction Test (IAT), Strengths and Difficulties Questionnaire (SDQ), Autism Spectrum Quotient (AQ), and Attention Deficit Hyperactivity Disorder Rating Scale-IV (ADHD-RS).

Results: Based on the total IAT score, 25 out of 55 participants were classified as having IA. Although there were no significant differences in AQ and Intelligence Quotient, the higher scores of ADHD symptoms in SDQ and ADHD-RS were observed in the IA group than the non-IA group. The IA group used portable games more often than the non-IA group.

Conclusion: The ADHD symptoms were strongly associated with IA in ASD adolescents. More intensive prevention and intervention for IA are needed especially for the ASD adolescents with ADHD symptoms.

1. Introduction

Network services are becoming important tools for adolescents. Serious problems associated with internet addiction (IA) among adolescents include refusal to go to school and mental health problems, such as loneliness, low self-esteem, insufficient sleep, anxiety, and depression (Kim et al., 2006). IA has been defined as an inability to control one's use of the internet despite adverse consequences and persists over a significant period (Kardefelt-Winther et al., 2017). In addition, some psychological problems have been documented as having associations with problematic behaviors using the internet, such as a lack of inhibition and problems in making self-controlled choices (Dong, Devito, Du, & Cui, 2012). Although IA has not been formally included in the Diagnostic and Statistical

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Manual of Mental Disorders (DSM-5) (American Psychiatric Association, 2013) or International Statistical Classification of Diseases and Related Health Problems (ICD-10) as a disorder, IA has become a severe worldwide mental health problem. DSM-5 lists internet gaming disorder under "conditions for further study," and "gaming disorder" will be included in the ICD-11 (World Health Organization, 2018).

Several studies have identified the association between IA and psychiatric disorders. Ho et al. (2014) reported that IA had been significantly associated with alcohol abuse, attention deficit hyperactivity disorder (ADHD), depression, and anxiety. ADHD is the most common psychiatric disorder among adolescents with IA (Bozkurt, Coskun, Ayaydin, Adak, & Zoroglu, 2013). In addition, a 2 year prospective study revealed that ADHD was the leading risk factor for IA in young adolescents (Ko, Yen, Chen, Yeh, & Yen, 2009). Therefore, ADHD should be well-evaluated and treated among cases of IA. In addition, the association between ADHD and IA might suggest that people with ADHD should be important target group of preventive scheduling for IA.

In clinical situation, IA coexists with autism spectrum disorder (ASD) and the association between two disorders is higher than expected by chance. However, there has been no enough data about this comorbidity.

Mazurek and Engelhardt (2013) reported that children with ASD spent more time playing video games and had higher problematic levels of video game use than children with normal development. Children with ASD were particularly related to excessive and problematic video game and internet use (MacMullin, Lunsky, & Weiss, 2016). These studies only compared IA between children with ASD and typically developing children. Children comorbid with ASD and IA might be also an important target group of preventive scheduling for IA. People with ASD tend to devote themselves to video games or internet use and prolong their addictive behaviors because of their autistic traits: restricted, repetitive patterns of behavior, interests, or activities. However, ASD adolescents with IA has not been well-evaluated or treated, either. Moreover, there have been few studies to investigate the characteristics of ASD with and without IA in a clinical setting. We hypothesized that the characteristics of ASD with IA were different from those of ASD without IA. The objective of this study was to compare the characteristic of ASD between the IA and the non-IA groups.

2. Methods

2.1. Participants

2.1.1. ASD population sampled

The participants of this study were outpatients in Center for Child Health, Behavior and Development, Ehime University Hospital, the only University Hospital in Ehime prefecture and Ehime Rehabilitation Center for Children, the only governmental center in Ehime prefecture. Almost 150 new patients per year were performed medical examination in the Center for Child Health and about 60 out of 150 patients were diagnosed as ASD. In the Ehime Rehabilitation Center for Children, almost 450 new patients per year were performed medical examination, and about 140 out of 450 patients were diagnosed as ASD. The most of the patients were physically handicapped children, although the number of ASD patients has been increasing in recent years. The study period was from August 2017 to March 2018.

2.1.2. Inclusion and exclusion criteria

The inclusion criteria were 1) adolescents aged 10–19 years; 2) who were diagnosed with ASD based on the DSM-5 criteria by board-certified child psychiatrists or pediatricians; 3) who visited the hospital or center on a regular basis; and 4) who signed informed consent forms, along with their parents. The exclusion criteria included patients who had an intelligence quotient (IQ) under 70.

2.2. Instruments

Participants' IQ was assessed using the Wechsler Intelligence Scale for Children, Fourth Edition, or the Wechsler Adult Intelligence Scale, Third Edition. Participants answered the Basic Information Questionnaire, Young's Internet Addiction Test (IAT), a self-reported version of the Strengths and Difficulties Questionnaire (self-reported SDQ). Parents of the participants answered the Autism Spectrum Quotient (AQ), ADHD Rating Scale-IV (ADHD-RS), and a parent-reported version of the Strengths and Difficulties Questionnaire (parent-reported SDQ).

2.2.1. Basic Information Questionnaire

The Basic Information Questionnaire included age, sex, and duration of internet use. Participants were asked to answer questions about the frequency of electronic device usages, such as television, radio, music player, laptop, tablet, smartphone, mobile phone, portable games, and home video games that connect to the internet.

2.2.2. IAT

The IAT comprises 20 items and is calibrated with scores between 1 and 5, total scores ranging from 20 to 100, with higher scores reflecting a greater tendency toward addiction (Young, 1996). We defined an IAT score ≥ 50 as the IA group and an IAT score ≤ 49 as the non-IA group as several studies have defined mild and severe addiction with an IAT score ≥ 50 as IA (Malak, Khalifeh, & Shuhaiber, 2017; Tateno et al., 2018; Xin et al., 2018).

2.2.3. SDQ

The SDQ is a 25-item screening instrument of emotional and behavioral problems in children and adolescents (Goodman, Ford, Simmons, Gatward, & Meltzer, 2000). The SDQ consists of five subscales, each comprising five items, including emotional symptoms, conduct problems, hyperactivity–inattention, peer problems, and prosocial behavior. The SDQ also confirmed the same factor structure, good internal consistency, and test–retest reliability in a large Japanese sample (Moriwaki & Kamio, 2014). The first four subscales deal with children's problematic behavior or difficulties, whereas the fifth subscale assesses prosocial behavior, which is positive behavior or strengths. The children's behavior was evaluated using a 3-point Likert scale, 0 (not true) to 2 (absolutely true). The total score for each scale ranges from 0 to 10.

2.2.4. AQ

The AQ is a self-assessment screening instrument that measures the degree to which an individual with normal intelligence shows autistic traits (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001). The AQ consists of 50 questions, with a score of 32 being suggested as indicating Asperger's syndrome or high functioning autism.

2.2.5. ADHD-RS

The ADHD-RS is an 18-item questionnaire and norm-referenced checklist that measures the symptoms of ADHD according to the DSM-IV. We used the home version of the scale completed independently by the parent, who reports the frequency of the symptoms over the past 6 months on a 4-point Likert scale, 0–3. Two subscales are distinguished on the ADHD-RS, including inattention and hyperactivity–impulsivity. Each subscale has a score ranging from 0 to 27. The Japanese version of the ADHD-RS home form was developed with good reliability and validity in ADHD children (Tani, Okada, Ohnishi, Nakajima, & Tsujii, 2010).

2.3. Sample size calculation

The sample size was calculated on the basis of two sample t-tests using G*power 3.1.9.2 software (Faul, Erdfelder, Buchner, & Lang, 2009). An effect size of 0.8, a significance level of $\alpha = 0.05$, and a statistical power of $1\text{-}\beta = 0.8$ were also considered. A power analysis indicated the need for 52 subjects. The sample size calculation was performed before recruiting study participants.

2.4. Ethical considerations

This study was approved by the Institutional Review Board of Ehime University Graduate School of Medicine in Toon, Ehime Prefecture, Japan. The authors obtained written informed consent from the participants and their parents.

2.5. Data analysis

Continuous variables are expressed as the mean ± standard deviation (SD). Categorical variables are expressed as numbers and percentages. For categorical variables, chi-square tests were employed. Participants' mean IAT scores were not distributed normally using the Shapiro–Wilk test. Therefore, the Spearman's correlation was used to investigate relationships between the IAT and other variables. The correlations between the IAT score and these variables indicated that there were statistically significant and moderately sized relationships over 0.40 using G*Power 3.1.9.2 software. The mean scores of some instruments' background data were compared using the Mann–Whitney *U* test between participants with and without IA. All tests were two sided and assumed a 5% significance level. All data were analyzed using SPSS Statistics (IBM Corp., Armonk, NY, USA) for Windows, version 23.0.

3. Results

3.1. Prevalence of IA

A flowchart of the recruitment process is depicted in Fig. 1. There were 55 eligible participants with ASD (42 males and 13 females) who completed this study with a 71.4% response rate. The mean age of the participants was 13.4 ± 2.0 years (male, 13.4 ± 2.1 years; female, 13.2 ± 1.8 years). The participants included 15 children in elementary school, 26 children in junior high school, 13 children in high school, and 1 adolescent college student. Twenty participants were diagnosed with comorbid ASD and ADHD. The prevalence of IA among participants with ASD was 45.5% (25/55), and nearly half of the participants were classified with IA. The mean IAT score was 46.4 ± 20.9. Cronbach's α coefficient for IAT was 0.952.

3.2. Descriptive statistics

The correlation between the IAT score and related variables are shown in Table 1. The IAT scores had a moderate correlation with duration of internet use on both weekdays and weekends, the subscale scores of hyperactivity–inattention in self- and parent-reported SDQ and the subscale score of hyperactivity–impulsivity in ADHD-RS. On the other hand, the IAT scores did not correlate with AQ and IQ.

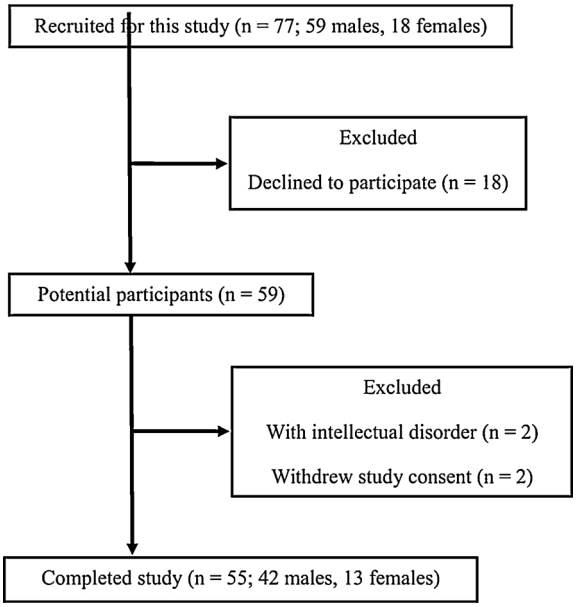

Fig. 1. Flowchart of study participants.

Table 1
Correlations between the IAT score and each variable.

	Mean ± SD	r
Age, y	13.4 ± 2.0	−0.028
IQ	96.7 ± 13.4	0.155
Duration of internet use		
Weekdays	200.8 ± 178.5	0.583***
Weekend	262.4 ± 191.9	0.580***
Self-reported SDQ		
Emotional symptoms	4.4 ± 2.6	0.319*
Conduct problems	3.2 ± 2.1	0.376**
Hyperactivity–inattention	5.4 ± 2.6	0.496***
Peer problems	3.7 ± 2.2	0.170
Prosocial behavior	4.4 ± 2.3	−0.089
Parent-reported SDQ		
Emotional symptoms	4.1 ± 2.7	0.253
Conduct problems	3.2 ± 2.2	0.247
Hyperactivity–inattention	5.5 ± 2.6	0.507***
Peer problems	4.6 ± 2.1	0.154
Prosocial behavior	4.5 ± 2.6	−0.183
AQ	29.7 ± 7.1	0.220
ADHD-RS		
Attention	11.9 ± 6.4	0.280*
Hyperactivity–impulsivity	5.4 ± 4.9	0.407**

Statistically significant and moderately sized relationships ($r > 0.40$); Spearman's correlations, ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$.
SDQ: the Strengths and Difficulties Questionnaire, IQ: intelligence quotient, AQ: the Autism Spectrum Quotient, ADHD-RS: the Attention Deficit Hyperactivity Disorder Rating Scale.

3.3. Comparison between characteristics of ASD between the IA and the non-IA group

The significant differences between variables in the IA and non-IA groups are shown in Table 2. There were significant differences in duration of internet use on both weekdays and weekends, the subscale scores of conduct problems and hyperactivity–inattention in self- and parent-reported SDQ, and the subscale score of hyperactivity–impulsivity in ADHD-RS between the IA and non-IA groups. These variables were significantly higher in the IA group than in the non-IA group. There were no significant differences in AQ and IQ scores, the number of participants comorbid with ADHD, and with medication between the IA and non-IA groups.

Table 2
Comparison of data between the IA and non-IA groups.

	IA(+), N = 25	IA(−), N = 30	*p*
Sex, male	20	22	0.562
Age, y	13.3 ± 2.2	13.5 ± 1.9	0.871
IQ	98.0 ± 13.9	95.6 ± 13.1	0.479
ADHD diagnosed, n (%)	11 (44.0)	9 (30.0)	0.283
[a]Medication, n (%)	11 (44.0)	10 (33.3)	0.422
Duration of internet use			
Weekdays	288.4 ± 170.3	127.8 ± 152.2	< 0.001***
Weekend	348.4 ± 158.2	190.7 ± 190.2	0.001**
Self-reported SDQ			
Emotional symptoms	5.1 ± 2.7	3.8 ± 2.4	0.088
Conduct problems	4.1 ± 1.9	2.4 ± 2.0	0.001**
Hyperactivity–inattention	6.5 ± 2.6	4.5 ± 2.2	0.002**
Peer problems	4.3 ± 2.3	3.3 ± 2.1	0.083
Prosocial behavior	4.2 ± 2.3	4.6 ± 2.3	0.474
Parent-reported SDQ			
Emotional symptoms	4.8 ± 2.9	3.5 ± 2.4	0.102
Conduct problems	3.8 ± 1.8	2.7 ± 2.4	0.021*
Hyperactivity–inattention	6.8 ± 2.3	4.4 ± 2.3	< 0.001***
Peer problems	5.0 ± 2.3	4.2 ± 2.0	0.200
Prosocial behavior	4.1 ± 2.8	4.8 ± 2.5	0.283
AQ	31.6 ± 7.3	28.1 ± 6.6	0.065
ADHD-RS			
Attention	13.7 ± 5.9	10.4 ± 6.4	0.051
Hyperactivity–impulsivity	7.7 ± 5.5	3.5 ± 3.0	0.003**

Mean scores were compared using the Mann–Whitney *U* test, ***p < 0.001, **p < 0.01, *p < 0.05.
SDQ: the Strengths and Difficulties Questionnaire, IQ: intelligence quotient, AQ: the Autism Spectrum Quotient, ADHD-RS: the Attention Deficit Hyperactivity Disorder Rating Scale.

[a] Medication: IA (+): atomoxetine (n = 4; 20, 25, 30, and 65 mg/day), guanfacine extended-release (n = 2; 2 and 3 mg/day), aripiprazole 1 mg/day, olanzapine 5 mg/day, methylphenidate extended-release 27 mg/day and atomoxetine 20 mg/day; atomoxetine 50 mg/day and aripiprazole 3 mg/day, guanfacine extended-release 2 mg/day and aripiprazole 6 mg/day (n = 1). Medication: IA (−): methylphenidate extended-release (n = 7; 27 and 36 mg/day), atomoxetine 50 mg/day and aripiprazole 3 mg/day, carbamazepine 200 mg/day, methylphenidate extended-release 27 mg/day and risperidone 1 mg/day; methylphenidate extended-release 54 mg/day and aripiprazole 3 mg/day (n = 1).

3.4. Accessibility of electronic devices

As shown in Fig. 2, the percentage of electronic device use over 5 days per week were compared between the IA and non-IA groups. A statistically significant difference was observed in the usage of portable games between the IA and non-IA group. In the IA group, 80.0% (20/25) of participants used portable games, whereas only 46.7% (14/30) used them in the non-IA group. No statistical difference was observed for the use of smartphones between the IA group (9/25, 36.0%) and non-IA group (10/30, 33.3%).

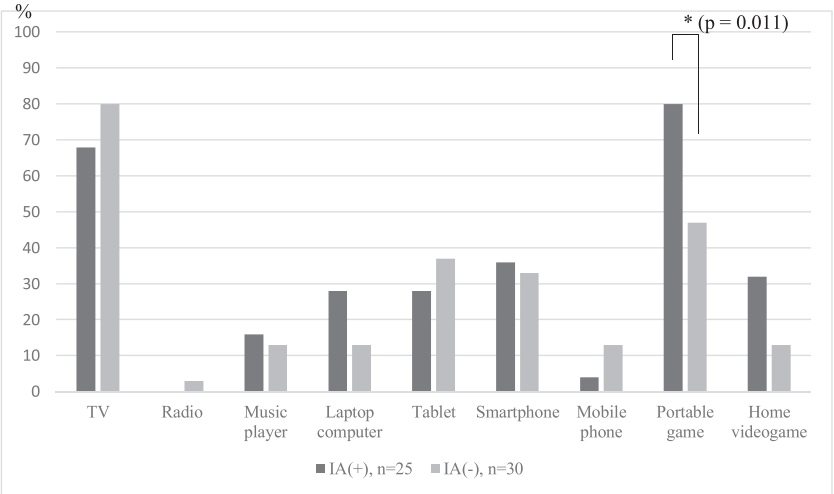

Fig. 2. Comparison of devices used in adolescents with ASD.

4. Discussion

The primary results of this study revealed that 45.5% (25/55) of the participants with ASD were classified as having IA, and their mean IAT score was 46.4 ± 20.9. The prevalence of IA among adolescents with ASD was significantly higher as 11.8% were identified as having IA in a general adolescent population in our previous study (Kawabe, Horiuchi, Ochi, Oka, & Ueno, 2016). Our findings indicate that the prevalence of IA in ASD is higher than in the general population and complement those reported by So et al. (2017) who found that the prevalence of IA among adolescents with ASD alone was 10.8%, and their mean IAT score was 45.2 ± 17.3.

The present studies demonstrated that 61.8% (34/55) of ASD adolescents used portable games which is higher than aged 10–17 adolescents among the general population in Japan, 39.2% of adolescents used portable games connected to the internet according to a report from the Ministry of Internal Affairs and Communications in 2017 (Ministry of Internal Affairs & Communications, 2018).

Another finding was that the percentage of ASD adolescents used portable games had significantly higher in the IA group than in the non-IA group. In our previous study involving the general population, we reported that smartphone use is one of the most contributing factors for IA (Kawabe et al., 2016). Mazurek, Shattuck, Wagner, and Cooper (2012) reported that more than 60.0% of ASD adolescents spent most of their free time using non-social media, such as watching television or playing video games, whereas only 13.2% spent time on social media, such as email or internet chatting and also reported that children with ASD have a strong preference for video games (Mazurek and Wenstrup, 2013). Unlike the general population, the high-frequent use of portable games might be a risk factor in ASD adolescents with IA.

Further finding of these studies is that no correlations were observed between the autistic traits using AQ, and the tendency of internet addiction using IAT. In previous studies, Romano, Truzoli, Osborne, and Reed (2014) demonstrated that psychometrically measured levels of autistic traits using the AQ were related to higher levels of internet-related problems. Liu et al. (2017) indicated that autistic traits measured by the Social and Communication Disorders Checklist are a risk factor for Internet gaming disorder. On the other hand, Chen, Chen, and Gau (2015) reported that low autistic traits using the AQ were associated with IA. These results suggest that the association of autistic traits and IA was incoherent, and AQ is not enough to grasp the association between ASD and IA. In future study, semi-structured interviews should be used to investigate the characteristic of ASD.

The main findings of this study revealed that there were significantly higher hyperactivity scores measured by SDQ and ADHD-RS in the IA group than in the non-IA group. In other words, ASD adolescents with ADHD symptoms had a higher risk of IA than those without ADHD symptoms. To our knowledge, this is the first report to investigate the relationship between IA and ADHD symptoms in a clinical study of ASD adolescents. Our study suggested that the strength of the ADHD characteristic is more important than the diagnosis of ADHD. ASD with IA might have more strong ADHD traits and this finding may help ASD patients with high risk of IA.

This study had several limitations. First, our assessment relied on self- and parent-reports. Second, we did not control for confounding factors, such as the domestic environment, including economic status. Third, the age range of the participants was broad. IA and characteristics of ASD vary among various age groups of the individuals. Forth, the present study had a cross-sectional design. Therefore, we could not assess cause and effect relationships. Further longitudinal and controlled studies should be performed.

In conclusion, the prevalence of IA and use of portable games in ASD adolescents was considerably higher than in the general population. Hyperactivity symptoms in ASD adolescents might be important factor the presence of IA. For cases of IA, psychiatric disorders including ADHD, depression, insomnia, and social phobia should be thoroughly assessed. To treat these disorders concurrently might provide benefit for the intervention of IA. On the other hand, it is also necessary to evaluate the existence of IA when treating adolescents with these psychiatric disorders. Generally, ASD children have the high risk of psychiatric disorders or challenging behaviors than children with typical development. In addition, IA have the potential to occurrence of psychiatric conditions such as depression, insomnia, and social phobia. In future, further research focusing on the mechanism of the comorbidity between IA and ASD is necessary, and it is also important to pay more intensive interventions for ASD adolescents who overuse internets and games.

Disclosure statement

The authors declare no conflict of interest. There are no sources of funding associated with this submission.

Author contributions

K.K., F.H., T.M., K.A., and T.J. collected the data. K.K. analyzed the data. K.K. and F.H. interpreted the results. F.H. and S.U. supervised all aspects of collection, analysis, and interpretation of the data. K.K. wrote the manuscript. E.I. and S.U. revised it. All authors contributed to and approved the final manuscript.

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