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# Relationship between problematic Internet use and age at initial weekly Internet use

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## FULL-LENGTH REPORT



## ABSTRACT

**Background and aims:** An important proportion of infants and adolescents in Japan are using Internet-equipped devices, including smartphones, tablets, and game consoles. However, the relationship between the risk of IA and the age at initial habitual Internet use remains unknown. We aimed to investigate this relationship among adolescents. **Methods:** We surveyed 1,775 subjects in seven public junior high schools in Kanagawa prefecture, Japan, in November 2017. Students were asked to complete the Young's Diagnostic Questionnaire (YDQ), which captured information regarding gender, school grade, night sleep, age at which they first started using the Internet at least once weekly, Internet usage situation, and Internet use time for purposes other than study. Data from subjects who reported experience of weekly Internet use were analyzed. **Results:** Junior high school students who were younger at initial weekly Internet use tended to have problematic Internet use (PIU) and to spend more time on Internet activities. In particular, initial weekly Internet use before the age of five in boys was associated with a significantly increased risk of PIU (YDQ  $\geq 5$ ), with an odds ratio of 14.955, compared with initial weekly Internet use after the age of 12. Smartphone ownership significantly increased the risk of PIU compared with no ownership among the total population and among girls. **Discussion and Conclusions:** Junior high school male students displayed a robust relationship between initial weekly Internet use and PIU, whereas junior high school female students displayed a particularly strong relationship between smartphone ownership and PIU. Therefore, longitudinal IA preventive education from an early age is necessary.

## KEYWORDS

age at initial customary Internet use, Internet addiction, junior high school students, smartphone, Young's diagnostic questionnaire

## INTRODUCTION

Most recent statistics show that in Japan, 37.2% of 2-year-old and nearly 50% of 3–5-year-old children were using Internet-equipped devices, including smartphones, tablets, and game consoles (Cabinet office government of Japan, 2017a). Broadly, infants, children, and youth utilize the Internet for various purposes such as entertainment, retrieving information, communication, learning, and others (Cabinet office government of Japan, 2017a,b). Due to widespread use and to avoid misuse, many schools educate students on Internet usage, and some educational institutions provide lectures and learning materials via the Internet. In 2001, 49.2% of Japanese children aged 6–12-year-used Internet services (Japan Ministry of Internal Affairs, 2001), but by 2017, this figure rose to 82.6% (Japan Ministry of Internal Affairs, 2017). Additionally, in 2017, 98.4% of 13- to 19-year-old Japanese adolescents and 83.5% of the total population used the Internet (Japan Ministry of Internal Affairs, 2017). The

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use of smartphones, in particular, is highly prevalent among youth. In 2017, 29.9% of Japanese elementary school students, 58.1% of junior high school students, and 95.9% of senior high school students accessed the Internet via smartphones (Cabinet office government of Japan, 2017b).

While the Internet has enabled convenience, several negative consequences, including Internet addiction (IA), have also been identified. Young developed screening tests such as the Young's Diagnostic Questionnaire (YDQ) (Young, 1996) and Young's Internet Addiction Test (YIAT) (Young, 1998) that have been adopted by researchers investigating IA for nearly two decades. In the line of clinical disorders, certain criteria were identified for diagnosis of IA. For example, Beard and Wolf (2001) proposed diagnostic criteria for IA with reference to the Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV criteria for pathological gambling. Four main components in these criteria—excessive use, withdrawal, tolerance, and negative repercussions—were identified in YDQ (Young, 2009). However, it has been argued that the concept of IA lacks academic rigor. For example, Baggio et al. (2018) identified that IA was related to other behavioral addictions (smartphone addiction, gaming addiction, and cybersex addiction), but the latter were relatively independent constructs. Therefore, due to this connection, between IA and independent constructs, IA could be conceptualized as an “umbrella construct.” Because Internet activities include various different types of activities (e.g., games, social networking services (SNS), movies, etc.), Starcevic and Aboujaoude (2017) proposed that IA should be replaced by terms that refer to specific behaviors. The diagnostic criteria for Internet Gaming Disorder (IGD), were included in the DSM-5, and the diagnostic criteria for Gaming Disorder (GD) have been proposed in the International Classification of Diseases (ICD)-11. However, an official definition and diagnostic criteria for IA remains lacking.

The usage rate of Internet among Japanese junior high school students was reported to be 95.1%, 74.1% for games and 68.1% for communication applications (Cabinet office government of Japan, 2017b). While some adolescents have not experienced specific Internet services (e.g., gaming, SNS, movies, etc.), there are few adolescents who have not experienced any Internet services at all. Therefore, we considered the term “IA” to be easily understood by most adolescents, rather than a specific addiction (e.g., gaming disorder, SNS addiction, etc.).

A Japanese school-based survey using the YDQ revealed that IA ( $YDQ \geq 5$ ) was prevalent in 6.2% of males and 9.8% of females (Mihara et al., 2016). School-based surveys using the YIAT among adolescents in six Asian countries (China, Hong Kong, Japan, South Korea, Malaysia, and the Philippines) revealed IA ( $YIAT \geq 70$ ) was prevalent in 1.2–4.9% of adolescents (Mak et al., 2014). In their meta-analysis, Cheng and Li (2014) estimated that the global prevalence of IA was 6.0% and is a worldwide problem among youths. It was reported that IA among youth associated to sleeping disorders (Choi et al., 2009), poor academic achievement (Stavropoulos, Alexandraki, &

Motti-Stefanidi, 2013), and worsening of psychiatric symptoms (Kawabe, Horiuchi, Ochi, Oka, & Ueno, 2016). In Japan, treatments for IA including group and individual psychotherapy, and comorbid psychiatric disorders are provided in some medical institutions and treatment camps in some youth facilities (Sakuma et al., 2017).

Some schools provide IA-preventive education for students and their guardians, based on the findings that IA preventive education effectively reduced Internet misuse (Korkmaz & Kiran-Esen, 2012) and number of Internet-based gamers (de Leeuw, de Bruijn, de Weert-van Oene & Schrijvers, 2010). Longitudinal IA studies have identified Male gender, attention deficit hyperactivity symptoms, hostility symptoms (Ko, Yen, Chen, Yeh, & Yen, 2009), low self-esteem, low family function, online game playing (Ko, Yen, & Yen, 2007), withdrawal symptoms, and depressive/anxiety symptoms (Cho, Sung, Shin, Lim, & Shin, 2013) as risk factors for IA. Cross-sectional studies have reported low socio-economic status (Lee & Kwame, 2015), family conflicts, study-related stress (Wang et al., 2011), smoking, drug abuse (Sung, Lee, Noh, Park & Ahn, 2013), Internet gambling (Critselis et al., 2013), poor parental relationships (Tang et al., 2014), and obesity (Koyuncu, Unsal, & Arslantas, 2014) to be IA risk factors.

Studies have suggested that early onset of substance use, particularly alcohol (Grant & Dawson, 1997) and nicotine (Lanza & Vasilenko, 2015) is associated with an increased risk of substance-dependence later in life. Along the same lines, younger age at first exposure to the Internet was associated with IA in adolescents or adults (Aktepe, Olgaç-Dündar, Soyöz, & Sönmez, 2013; Kamal & Mosallem, 2013; Koyuncu et al., 2014; Lee, Shin, Cho, & Shin, 2014; Ni, Yan, Chen, & Liu, 2009; Tsitsika et al., 2014). Though it has been noted that it is difficult for parents to prevent their children from occasionally using the Internet, it is possible for parents to prevent their children from habitual use of the Internet. This aspect has not been investigated in previous studies examining the relationship between the risk of IA and onset of habitual use of the Internet in early childhood.

This study was aimed at preventing IA in students. We investigated this relationship among junior high school students in order to help create longitudinal IA-preventive education based on risk factors from an early age.

## METHODS

### Participants

This survey was conducted at seven public junior high schools in a city in Kanagawa prefecture, Japan, in November 2017. Kanagawa prefecture is located near Tokyo, the capital of Japan. Kanagawa prefecture has a population of approximately nine million, and comprises several large cities. Subjects enrolled in the survey were students of all grades in seven public junior high schools ( $n = 2,454$  as of May 1, 2017). A total of 2,155 students participated in the survey, of whom 1,825 completed the questionnaire. We



Table 1. Gender, school grade, bedtime, family rules on Internet use, and average duration in minutes of daily Internet use by Young's Diagnostic Questionnaire (YDQ) score

	Total (N = 1,775)	NIU <sup>a</sup> group (N = 1,616)	PIU <sup>b</sup> group (N = 159)	Statistics
Gender (/Total × 100 (%))				$\chi^2 = 5.73, P = 0.020$
Male	864 (100.0%)	801 (92.7%)	63 ((7.3%)	
Female	911 (100.0%)	815 (89.5%)	96 (10.5%)	
School Grade (/Total × 100 (%))				$\chi^2 = 8.09, P = 0.018$
7th	641 (100.0%)	600 (93.6%)	41 (6.4%)	
8th	573 (100.0%)	514 (89.7%)	59 (10.3%)	
9th	561 (100.0%)	502 (89.5%)	59 (10.5%)	
Bedtime on weekdays (/Total × 100 (%))				$\chi^2 = 53.54, P < 0.001$
Before or at 21:59 hours	152 (100.0%)	143 (94.1%)	9 (5.9%)	
22:00–22:59 hours	491 (100.0%)	465 (94.7%)	26 (5.3%)	
23:00–23:59 hours	592 (100.0%)	553 (93.4%)	39 (6.6%)	
0:00–0:59 hours	336 (100.0%)	288 (85.7%)	48 (14.3%)	
At or after 1:00 hours	204 (100.0%)	167 (81.9%)	37 (18.1%)	
Bedtime on holidays (/Total × 100 (%))				$\chi^2 = 93.36, P < 0.001$
Before or at 21:59 hours	159 (100.0%)	151 (95.0%)	8 (5.0%)	
22:00–22:59 hours	447 (100.0%)	433 (96.9%)	14 (3.1%)	
23:00–23:59 hours	533 (100.0%)	490 (91.9%)	43 (8.1%)	
0:00–0:59 hours	353 (100.0%)	321 (90.9%)	32 (9.1%)	
At or after 1:00 hours	283 (100.0%)	221 (78.1%)	62 (21.9%)	
Family rules regarding Internet use				$\chi^2 = 0.67, P = 0.410$
Yes	1,070 (100.0%)	979 (91.5%)	91 (8.5%)	
No	705 (100.0%)	637 (90.4%)	68 (9.6%)	
Average minutes of daily Internet use on weekdays (mean ± SD)	108.9 ± 111.9	100.3 ± 103.5	196.4 ± 150.2	$F = 41.69, P < 0.001$
Average minutes of daily Internet use on holidays (mean ± SD)	186.5 ± 195.5	168.3 ± 173.3	371.2 ± 290.7	$F = 92.24, P < 0.001$

<sup>a</sup>NIU: Normal Internet use (YDQ score ≤ 4 points).<sup>b</sup>PIU: Problematic Internet use (YDQ score ≥ 5 points).

analyzed 1,775 participants who experienced weekly Internet use. Of these, 50 subjects who completed the questionnaire and answered no experience of weekly Internet use were excluded, 41 (82.0%) of individuals spent 0 minutes on Internet use during weekdays, 35 (70.0%) spent 0 minutes on Internet during holidays, and 41 (82.0%) with a YDQ score of 0 points indicating light Internet users.

## Procedure and assessment

The YDQ is a self-reported scale concerning Internet addiction and consists of eight questions, with a “yes” or “no” response and scores ranging from 0 to 8. Young proposed that respondents who answered “yes” to five or more items were addictive Internet users (Young, 1996). The YDQ has been previously used in several studies and because of the small number of items; it is an easy and feasible tool to use for the purpose outlined in this study. The Japanese version of the YDQ (Ohida et al., 2014) was back translated to avoid language bias. The Cronbach's alpha of the YDQ was 0.719 in this study, and subjects whose YDQ scores ranged from 0–4 points were classified as the Normal Internet Use (NIU) group, and the subjects whose scores ranged from 5–8 points were classified as the Problematic Internet Use (PIU) group. This questionnaire included items regarding gender, school grade, night sleep, age at which they first started using the

Internet at least once a week, Internet usage situation, Internet use time for purposes other than study and Japanese version of the YDQ (Ohida et al., 2014; Young, 1996). In November 2017, students completed the self-reported anonymous questionnaires in their classrooms by responding to the questionnaire that were then sealed in individual envelopes and submitted to their teachers. The staffs of the Board of Education unsealed the envelopes and entered the data into a database. After this survey, the authors lectured on IA-prevention measures to students and teachers in each participating school and explained the results and their implications.

## Statistical analysis

A comparison of continuous data among groups by age at initial weekly Internet use was assessed with a one-way analysis of variance (ANOVA), and a post-hoc analysis between the group with initial weekly Internet use after 12 years of age and the group with initial weekly Internet use before this age was performed using Dunnett's test. The comparison of continuous data between NIU and PIU group were assessed using the Student's *t*-test. The comparison of categorical data between NIU and PIU group were assessed using a chi-square test. A multivariable logistic regression analysis was conducted to assess the relationship between PIU and independent variables among all participants, males, and females. The



independent variables in model 1 (Table 3) were the type of Internet services used. The independent variables included in model 2 (Table 5) included gender, school grade, age at initial weekly Internet use (more than 12 years old vs. 10–11, 8–9, 6–7, or less than 5 years old), ownership of a smartphone (none vs. smartphone), and family rules regarding Internet use. A *P*-value of less than 0.05 was considered statistically significant. All the statistical analyses were performed using SPSS Statistics, version 22.0 (SPSS Inc., Chicago, IL, USA).

## Ethics

The study procedures were performed in accordance with the Declaration of Helsinki. The study protocol was approved by the ethics committee of the National Hospital Organization Kurihama Medical and Addiction Center and addiction preventive education committee of a city. Before surveying, the authors and teachers sent letters to the students' guardians (e.g., parents) explaining the purpose of the study, the contents of the questionnaire, the opportunity to refuse participation in the study, the protection of the students' private information, the presentation at a conference, and the publication of this study's findings. The students' teachers also relayed the information to the students. The questionnaire was anonymous, and the students' private information was protected. Subjects gave informed consent, and subject's anonymity was preserved.

## RESULTS

### Background, bedtime, and family rules by YDQ score

Subject demographics including gender, as well as school grade, bedtime, family rules regarding Internet use, and the average duration of daily Internet use in minutes, and subject's YDQ score are provided in Table 1. In total, 159 (9.0%) of the participants (*n* = 1775) were classified as belonging to the PIU group; 864 (48.7%) of the subjects were male; 641 (36.1%) were in seventh grade; 573 (32.3%) were in eighth grade; 561 (31.6%) were in ninth grade; 540 (30.4%) of the subjects went to bed at or after 0:00 h on weekdays; and 636 (35.8%) of the subjects went to bed at or after 0:00 h on holidays. The rate of PIU was higher among females compared to that of males, and significantly increased with school grades. Bedtime on weekdays and holidays were significantly later in the PIU group than in the NIU group. Additionally, the families of 1,071 (60.3%) subjects had rules regarding Internet use. The subjects spent an average of 108.9 min on the Internet on weekdays and 186.5 min on the Internet on holidays. The average duration of Internet use on weekdays and holidays were significantly longer among PIU group than among NIU group.

### Association between type of Internet services used and risks of PIU

The type of Internet services used by YDQ score is provided in Table 2. In male subjects, the rate of "e-mail, chat, and

Internet telephone," "blog and internet bulletin board," "SNS," "online game," and "shopping and auction" users were significantly higher in PIU group than in the NIU group. In female subjects, the rate of "blog and internet bulletin board," "SNS," "online game," "movie and music," "shopping and auction," and "other contents" users were significantly higher in PIU group than in NIU group.

Table 3 shows the association between type of Internet services used and the risk of PIU. In all subjects, "blog and internet bulletin board," "SNS," "online game," "movie and music" were associated with a significantly increased risk of PIU; "Information and news searching" were associated with a significantly decreased risk of PIU. Among males, "blog and internet bulletin board," "SNS," and "online game" were associated with a significantly increased risk of PIU. In females, "SNS," "online game," and "movie and music" were associated with a significantly increased risk of PIU, and "Information and news searching" were associated with a significantly decreased risk of PIU.

Table 2. Type of Internet services used by Young's Diagnostic Questionnaire (YDQ) score

	NIU <sup>a</sup> group	PIU <sup>b</sup> group	Statistics
<b>Males</b>			
Information and news searching	488 (60.9%)	43 (68.3%)	$\chi^2 = 1.33$ , $P = 0.283$
E-mail, chat, and Internet telephone	428 (53.4%)	42 (66.7%)	$\chi^2 = 4.12$ , $P = 0.049$
Blog and internet bulletin board	74 (9.2%)	22 (34.9%)	$\chi^2 = 39.01$ , $P < 0.001$
Social networking services	137 (17.1%)	29 (46.0%)	$\chi^2 = 31.49$ , $P < 0.001$
Online game	391 (48.8%)	46 (73.0%)	$\chi^2 = 13.69$ , $P < 0.001$
Movie and music	613 (76.5%)	53 (84.1%)	$\chi^2 = 1.91$ , $P = 0.212$
Shopping and auction	118 (14.7%)	16 (25.4%)	$\chi^2 = 5.07$ , $P = 0.030$
Others	74 (9.2%)	6 (9.5%)	$\chi^2 = 0.01$ , $P = 0.940$
<b>Females</b>			
Information and news searching	538 (66.0%)	62 (64.6%)	$\chi^2 = 0.08$ , $P = 0.820$
E-mail, chat, and internet telephone	600 (73.6%)	70 (72.9%)	$\chi^2 = 0.022$ , $P = 0.903$
Blog and internet bulletin board	66 (8.1%)	16 (16.7%)	$\chi^2 = 7.70$ , $P = 0.012$
Social networking services	264 (32.4%)	58 (60.4%)	$\chi^2 = 29.52$ , $P < 0.001$
Online game	162 (19.9%)	38 (39.6%)	$\chi^2 = 19.47$ , $P < 0.001$
Movie and music	631 (77.4%)	88 (91.7%)	$\chi^2 = 10.48$ , $P = 0.001$
Shopping and auction	104 (12.8%)	24 (25.0%)	$\chi^2 = 10.65$ , $P = 0.003$
Others	75 (9.2%)	16 (16.7%)	$\chi^2 = 5.32$ , $P = 0.029$

<sup>a</sup>NIU: Normal Internet use (YDQ score  $\leq 4$  points).

<sup>b</sup>PIU: Problematic Internet use (YDQ score  $\geq 5$  points).





Table 3. Associations between type of Internet services used and risks of Problematic Internet use (PIU: YDQ<sup>a</sup>) score  $\geq 5$  points

Total				Males			Females		
Adjusted OR		95% CI	P-value	Adjusted OR	95% CI	P-value	Adjusted OR	95% CI	P-value
Information and news searching									
No	Reference			Reference			Reference		
Yes	0.646	0.434–0.963	0.032	0.699	0.362–1.352	0.288	0.580	0.350–0.961	0.034
E-mail, chat, and internet telephone									
No	Reference			Reference			Reference		
Yes	0.468	0.569–1.296	0.468	1.133	0.601–2.135	0.699	0.593	0.343–1.025	0.061
Blog and internet bulletin board									
No	Reference			Reference			Reference		
Yes	1.703	1.064–2.726	0.027	3.277	1.634–6.573	0.001	1.077	0.538–2.155	0.834
Social networking services									
No	Reference			Reference			Reference		
Yes	3.164	2.154–4.646	<0.001	2.594	1.337–5.034	0.005	3.006	1.844–4.902	<0.001
Online game									
No	Reference			Reference			Reference		
Yes	1.704	1.197–2.428	0.003	1.923	1.033–3.580	0.039	2.092	1.292–3.390	0.003
Movie and music									
No	Reference			Reference			Reference		
Yes	1.780	1.040–3.047	0.035	0.968	0.453–2.065	0.932	3.003	1.360–6.733	0.007
Shopping and auction									
No	Reference			Reference			Reference		
Yes	1.132	0.732–1.750	0.578	0.968	0.485–1.932	0.927	1.339	0.755–2.375	0.318
Others									
No	Reference			Reference			Reference		
Yes	0.484	0.717–2.021	0.484	0.284	0.231–1.536	0.284	1.714	0.909–3.232	0.096

<sup>a</sup>YDQ: Young's Diagnostic Questionnaire.

### Association between Internet use and YDQ score by age at initial weekly Internet use

The type of Internet services used by age at initial weekly Internet use is provided in Table 4. Both male and female subjects who were younger at initial weekly Internet use tended to use several types of Internet services. Figure 1 shows the average duration of daily Internet use in minutes on weekdays and holidays by age at initial weekly Internet use. The average daily duration of Internet use tended to be longer in both male and female subjects, who began using the Internet weekly at a younger age. Figure 2 shows the YDQ scores by the age at initial weekly Internet use. Both male and female subjects who were younger at initial weekly Internet use tended to have PIU.

### Factors associated with the risk of problematic Internet use (PIU)

Table 5 shows the association between multiple factors (gender, school grade, initial age at weekly Internet use, ownership of a private smartphone, family rules regarding Internet use) and the risk of PIU. Females had a significantly increased risk of PIU with an odds ratio (OR) of 1.656 compared with males. Higher school grades were associated with higher ORs for PIU. Younger age at initial weekly Internet use was associated with higher ORs for PIU among males and females. Among males, initial weekly Internet use before the age of five was associated with a significantly increased risk of PIU, with an OR of 14.955, compared with

initial weekly Internet use after the age of 12. Owning a smartphone was significantly associated with an increased risk of PIU among female subjects. Family rules regarding Internet use were not significantly associated with the risk of PIU.

## DISCUSSION

This cross-sectional survey investigated factors associated with an increased risk of PIU. Our results showed that female gender was associated with a significantly higher risk of PIU with an OR of 1.656 compared to male. Previous studies did not show a conclusive relationship between IA and gender. Whereas some reported that males have a higher risk for IA (Jang, Hwang, & Choi, 2008; Ko et al., 2009; Yen et al., 2008), others reported that gender was not significantly associated with an increased risk for the occurrence of IA (Choi et al., 2009; Wang et al., 2011), and yet, others showed that the prevalence rate of IA was higher in females (Kuss, van-Rooij, Shorter, Griffiths, & van-de Mheen, 2013; Mihara et al., 2016). We showed in this study that subjects in higher school grades displayed a significant association with PIU compared to those in lower grades. It was reported that high school students in higher school grades displayed a significant association with IA (Hao, Oh, Subramanian, Kim, & Kawachi, 2014; Mihara et al., 2016). While our results are in concordance with previous findings, we also found that family rules regarding Internet use were not related to the participant's risk for PIU.



Table 4. Type of Internet services used by age at initial weekly Internet use (/Total × 100(%))

	≤5 years old	6 or 7 years old	8 or 9 years old	10 or 11 years old	≥12 years old	Statistics
<b>Males</b>	(N = 54)	(N = 109)	(N = 215)	(N = 311)	(N = 175)	
Information and news searching	37 (68.5%)	76 (69.7%)	141 (65.6%)	175 (56.3%)	102 (58.3%)	$\chi^2 = 10.10$ , $P = 0.039$
E-mail, chat, and internet telephone	36 (66.7%)	70 (64.2%)	121 (56.3%)	156 (50.2%)	87 (49.7%)	$\chi^2 = 11.62$ , $P = 0.020$
Blog and internet bulletin board	16 (29.6%)	19 (17.4%)	24 (11.2%)	27 (8.7%)	10 (5.7%)	$\chi^2 = 30.18$ , $P < 0.001$
Social networking services	20 (37.0%)	25 (22.9%)	46 (21.4%)	52 (16.7%)	23 (13.1%)	$\chi^2 = 18.09$ , $P = 0.001$
Online game	37 (68.5%)	73 (67.0%)	116 (54.0%)	140 (45.0%)	71 (40.6%)	$\chi^2 = 30.51$ , $P < 0.001$
Movie and music	44 (81.5%)	90 (82.6%)	171 (79.5%)	235 (75.6%)	126 (72.0%)	$\chi^2 = 6.15$ , $P = 0.188$
Shopping and auction	16 (29.6%)	23 (21.1%)	37 (17.2%)	37 (11.9%)	21 (12.0%)	$\chi^2 = 16.03$ , $P = 0.003$
Others	10 (18.5%)	14 (12.8%)	25 (11.6%)	23 (7.4%)	8 (4.6%)	$\chi^2 = 14.48$ , $P = 0.006$
<b>Females</b>	(N = 31)	(N = 119)	(N = 212)	(N = 327)	(N = 222)	
Information and news searching	26 (83.9%)	84 (70.6%)	146 (68.9%)	207 (63.3%)	137 (61.7%)	$\chi^2 = 9.16$ , $P = 0.057$
E-mail, chat, and internet telephone	26 (83.9%)	90 (75.6%)	161 (75.9%)	242 (74.0%)	151 (68.0%)	$\chi^2 = 6.11$ , $P = 0.191$
Blog and internet bulletin board	10 (32.3%)	15 (12.6%)	14 (6.6%)	32 (9.8%)	11 (5.0%)	$\chi^2 = 28.53$ , $P < 0.001$
Social networking services	13 (41.9%)	54 (45.4%)	78 (36.8%)	114 (34.9%)	63 (28.4%)	$\chi^2 = 10.77$ , $P = 0.029$
Online game	13 (41.9%)	39 (32.8%)	51 (24.1%)	69 (21.1%)	28 (12.6%)	$\chi^2 = 27.35$ , $P < 0.001$
Movie and music	27 (87.1%)	98 (82.4%)	170 (80.2%)	255 (78.0%)	169 (76.1%)	$\chi^2 = 3.51$ , $P = 0.476$
Shopping and auction	11 (35.5%)	31 (26.1%)	30 (14.2%)	39 (11.9%)	17 (7.7%)	$\chi^2 = 34.72$ , $P < 0.001$
Others	7 (22.6%)	16 (13.4%)	19 (9.0%)	36 (11.0%)	13 (5.9%)	$\chi^2 = 11.89$ , $P = 0.018$

### Relationship between PIU and smartphone use

Smartphones are known to be addictive Internet devices because of their portability and operability than other devices. Kawabe et al. (2016) reported that accessibility to smartphones was an important risk factor for IA. Screening tests for smartphone addiction have also been developed (Kim, Lee, Lee, Nam, & Chung, 2014; Kwon et al., 2013). It has been reported that females display a significantly increased risk for smartphone addiction compared to males (Choi et al., 2015; Haug et al., 2015). In our study, we found smartphone ownership was significantly associated with higher risk for PIU compared with no ownership in both the total population and female subjects, but not in male subjects. Because many students already possess smartphone, parents should be encouraged to provide them the opportunity to be educated about appropriate smartphone usage.

### Relationship between PIU and type of Internet services

Previous studies revealed that using "Online games" (Mihara et al., 2016; Tsitsika et al., 2014), "SNS" (Mihara et al., 2016; Tsitsika et al., 2014), and "Blog and bulletin board" (Mihara

et al., 2016) were associated with an increased risk for IA. In our study, both male and female subjects who were younger at initial weekly Internet use tended to use many types of Internet services including those related to PIU. Adolescents who were younger at initial weekly Internet use tended to prefer more addictive Internet content. This group of subjects was able to use more addictive Internet content by using Internet for a prolonged period of time. The reason for this relationship between younger at initial customary Internet use and using more addictive Internet services was unclear in this study, and should be addressed in future investigations.

### Relationship between PIU and age at initial habitual Internet use

Associations between age at initial Internet use and IA have been previously reported (Aktepe et al., 2013; Kamal & Mosallem, 2013; Koyuncu et al., 2014; Lee et al., 2014; Ni et al., 2009; Tsitsika et al., 2014). For example, Lee et al. (2014) reported that 4.1%, 2.6%, and 1.8% of participants, whose age at initial Internet use was younger than 7, 8–10, and 11 years or older, respectively, had suspected IA (YIAT



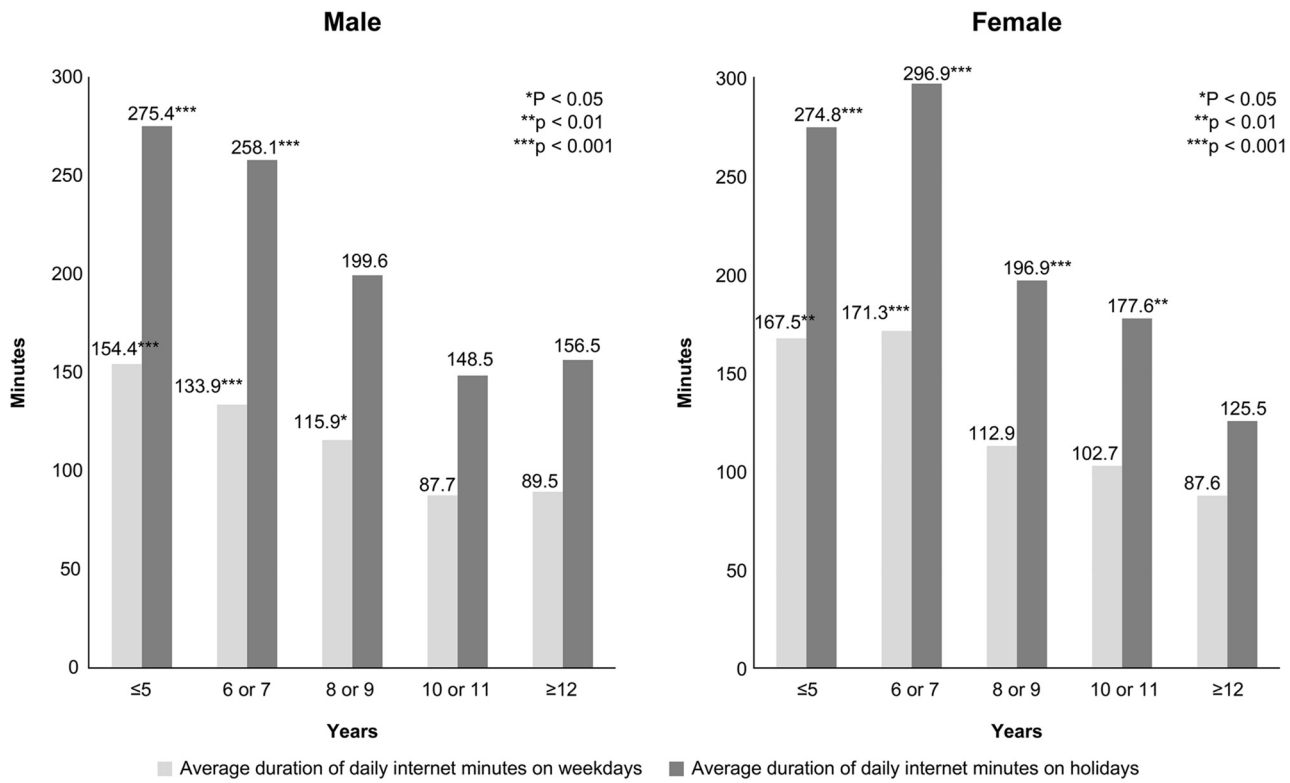


Figure 1. Average duration in minutes of daily Internet use on weekdays and holidays by age at initial weekly Internet use

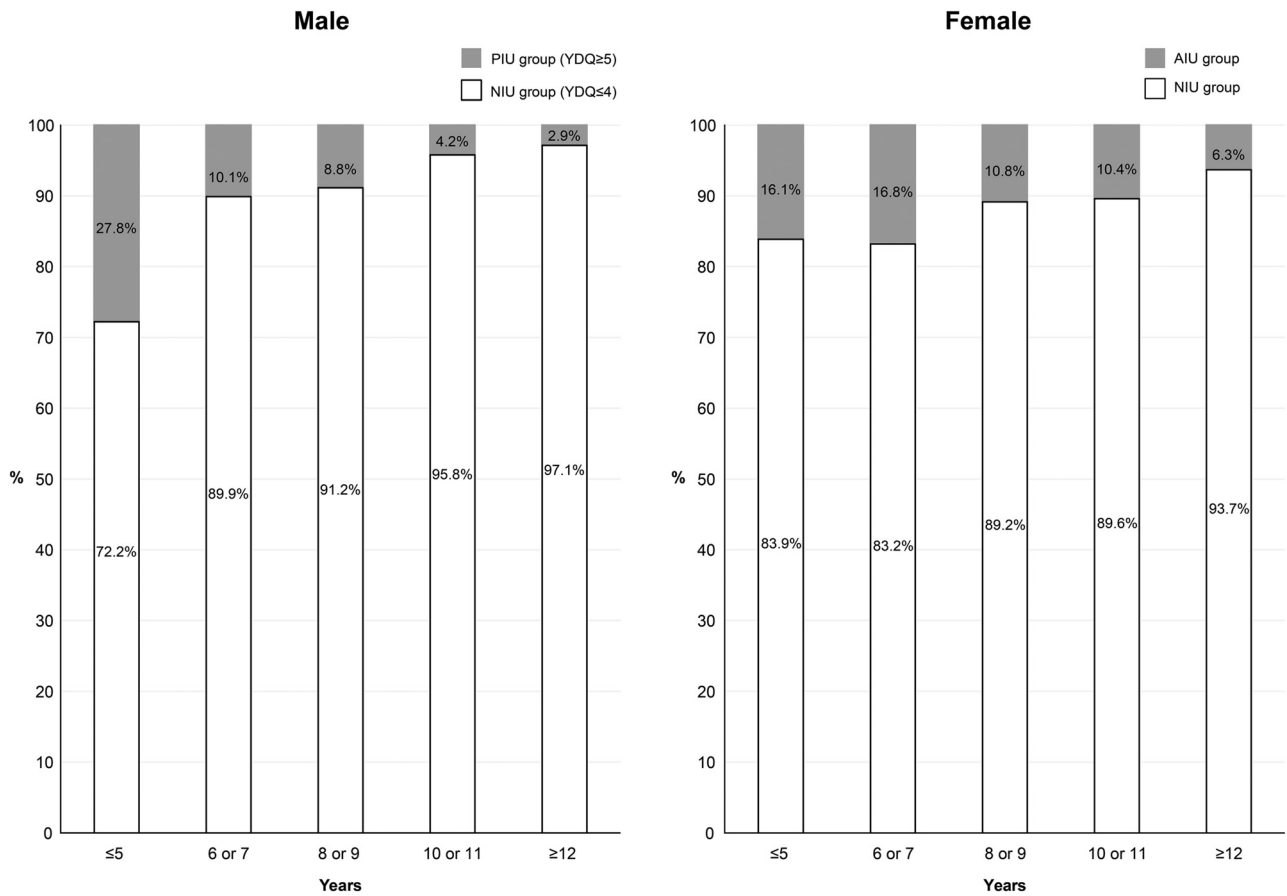


Figure 2. Young's Diagnostic Questionnaire (YDQ) score by age at initial weekly Internet use



Table 5. Associations between gender, school grade, age at initial weekly Internet use, ownership of private portable phone, family rules regarding Internet use, and the risks of problematic Internet use (PIU: YDQ<sup>a</sup>) score  $\geq 5$  points

	Total			Males			Females		
	Adjusted OR	95% CI	p-value	Adjusted OR	95% CI	P-value	Adjusted OR	95% CI	P-value
Gender									
Male	Reference								
Female	1.656	1.175–2.334	0.004						
School Grade									
7th	Reference			Reference			Reference		
8th	1.748	1.145–2.669	0.01	1.805	0.918–3.549	0.087	1.769	1.024–3.058	0.041
9th	1.980	1.285–3.052	0.002	2.107	1.067–4.161	0.032	1.959	1.114–3.447	0.020
Age at initial weekly Internet use									
12 $\leq$	Reference			Reference			Reference		
10–11	1.857	1.064–3.242	0.03	1.757	0.608–5.079	0.298	1.943	1.004–3.760	0.048
8–9	2.596	1.467–4.595	0.001	3.913	1.412–10.847	0.009	2.058	1.014–4.177	0.046
6–7	3.633	1.977–6.674	<0.001	4.481	1.488–13.497	0.008	3.328	1.589–6.969	0.001
$\leq 5$	7.422	3.691–14.923	<0.001	14.955	5.053–44.260	<0.001	2.977	0.975–9.087	0.055
Smartphone ownership									
None	Reference			Reference			Reference		
Smartphone	4.083	1.771–9.416	0.001	1.859	0.644–5.365	0.251	<b>8.535</b>	2.076–35.625	0.003
Family rules regarding Internet use									
No	Reference			Reference			Reference		
Yes	0.746	0.671–1.331	0.945	0.976	0.558–1.677	0.929	0.949	0.605–1.484	0.820

<sup>a</sup>YDQ: Young's Diagnostic Questionnaire.

$\geq 70$ ), in a Korean middle school survey. Conversely, [Malak, Khalifeh, and Shuhaiber \(2017\)](#) reported that age at first Internet use was not significantly associated with the future risk of IA (YIAT  $\geq 50$ ). It must be acknowledged that parents find it difficult to prevent their children from occasionally using the Internet in recent years, largely due to the rampant use of Internet-based devices at homes.

Almost all individuals with IA spend considerable lengths of time on Internet activities; IA is strongly associated with Internet overuse ([Aktepe et al., 2013; Koyuncu et al., 2014; Mihara et al., 2016](#)). The onset of IA was assumed to be associated with an environment in which the Internet is used for considerable lengths of time. Since children are unable to do so without the consent and oversight of parents and other adults who prepare the Internet environment for them, IA may not be necessarily a result of children merely using the Internet, but with the active participation of their guardians as well.

We hypothesized that the initial habitual use of the Internet might have a stronger association with IA than initial use of the Internet. It may be possible for parents to prevent their children from habitual use of the Internet. However, a relationship between the risk of IA and habitual Internet use in early childhood was not borne out in previous studies.

Our survey revealed that the risk of PIU was positively associated with a younger age at initial weekly Internet use. In particular, initial weekly Internet use before the age of five in boys was associated with a significantly increased risk of PIU, with an odds ratio of 14.955 compared with initial weekly Internet use after 12 years of age. In addition, our results showed that the average duration of daily Internet time and the utilization rate of each Internet services increased with younger age at initial weekly Internet use.

These results confirmed the relationship between PIU and age at initial weekly Internet use.

While obvious links between IA and Internet use have been made, the previous surveys were unable to conclude an association between IA and the duration of Internet use. For example, [Ko et al. \(2009\)](#) reported that using the Internet for more than four years does not significantly predict the risk of future IA, whereas, [Kormas, Critselis, Janikian, Kafetzis, and Tsitsika \(2011\)](#) reported that more than 12 months of Internet use was significantly related to IA.

The IA prevalence rate in adults tends to be lower than the rate in youth. For example, [Park, Jeon, Bae, Seong, and Hong \(2017\)](#) reported that the prevalence rate of IA (YDQ  $\geq 5$ ) was 1.0% in a survey of adults. Currently, although most adults use the Internet, this was not available to them in their childhood since widespread use of the Internet began only two decades ago. These results suggest that IA may be more closely related to the age at initial habitual use rather than the number of years of Internet use.

Although adults tend to focus on Internet use in children, emphasis must be placed on the possibility of children's future IA onset. In addition, children who have already used the Internet at an early age must be monitored against future IA onset. Overall, our study throws support for longitudinal IA-preventive education from an early stage; moreover, prevention based on these risk factors should also target parents who can inculcate appropriate use of the Internet in children, starting from infancy.

## Limitations

This study has several limitations. First, our assessment was based solely on self-reported data; objective viewpoints (e.g., those of parents or teachers) were lacking. Further, since





students' childhood memories may not be accurate, we assumed that the subjects might be able to remember their first customary and habitual Internet use rather than initial use. Second, because our study design was cross-sectional, a cause-effect relationship could not be established, which would have been possible with longitudinal studies. Third, all participants were enrolled in public junior high schools in a city area. Thus, whether our findings are applicable to private-school students and adolescents living in rural areas is unclear. Fourth, certain PIU risk factors (e.g., attention deficit hyperactivity symptoms, family function, socioeconomic status etc.) were not considered in our study due to the nature of the questionnaire. Future studies should address these concerns.

## CONCLUSIONS

Junior high school students who were younger at initial weekly Internet use tended to have PIU and to spend more time on Internet activities. In particular, initial weekly Internet use before the age of five in boys was associated with a significantly increased risk of PIU, with an OR of 14.955, compared with initial weekly Internet use after the age of 12. Smartphone ownership significantly increased the risk of PIU compared with no ownership among the total population and among girls. Longitudinal IA preventive education from an early stage is necessary, and prevention based on these risk factors should also target parents who can inculcate appropriate use of the Internet in children, starting from infancy.

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**Author's contribution:** All the authors contributed to the design of this study. H. N. performed the survey. H. N. conducted IA preventive lectures in each school after this survey. H. N. and S. H. performed the statistical analysis. H. N. wrote the first draft of this manuscript, and all the authors contributed to and approved the final manuscript.

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