A Systematic Study on the Reliability and Validity of the Japanese Smartphone Addiction Scale among the Youth in Japan

Yuichiro Otsuka (otsuka.yuichiro@nihon-u.ac.jp)
Nihon Daigaku Igakubu Daigakuin Igaku Kenkyuka https://orcid.org/0000-0001-8247-9235
Yoshitaka Kaneita
Nihon Daigaku Igakubu Daigakuin Igaku Kenkyuka
Osamu Itani
Nihon Daigaku Igakubu Daigakuin Igaku Kenkyuka
Yuuki Matsumoto
Nihon Daigaku Igakubu Daigakuin Igaku Kenkyuka

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Abstract

Background: Few studies in Japan have investigated smartphone addiction utilizing an international scale. This study aimed to evaluate the reliability and validity of the Japanese version of the Smartphone Addiction Scale (SAS) in Japanese youths and to examine the factors underlying smartphone overuse.

Methods: We conducted a questionnaire survey in 2018 with participants from one high school (n=1,050) and one vocational school (n=83; age range, 15-24 years; median age, 17 years) in Japan. Data from 1,037 (male: 60.8%, n=631) questionnaires were analyzed.

Results: Factor analysis showed six factors with factor loading ranging from 0.42 to 0.72 for the Japanese version of the SAS. Cronbach's alpha was 0.94 for the 33 items in this scale. The scale showed good reliability for test-retest scores (intraclass correlation coefficient 3,1 =0.92). Multiple linear regression analyses showed that the factors related to smartphone overuse were female gender, long smartphone usage duration, poor mental health, contact with virtual friends, and being a smartphone zombie. Contact with family and real friends were not associated with smartphone overuse.

Conclusions: Although smartphone overuse differs depending on one's cultural and social background, the Japanese version of the SAS is as good as the other language versions. Thus, this scale was shown to be reliable and valid in the Japanese youth.

Background

Internet usage has rapidly spread worldwide and become an indispensable part of our lives. However, problematic internet use, where daily life and health are hindered owing to over-absorption and impaired control over internet usage, has created serious social and health problems such as psychopathology including depression and anxiety [1, 2]. Problematic internet use seems to be common mostly among adolescents and young adults [2]. Particularly, higher prevalence has been reported in Southeast Asian countries; 8% of the Chinese and 10.7% of the Korean adolescents face problematic internet use [3, 4]. In Japan, 6.2% of men and 9.8% of women adolescents experienced problematic internet use [5].

Recently, and globally, daily internet usage has been shifting from personal computers (PC) to highly-portable smartphones; and people feel inseparable from them [6]. In Japan, smartphone ownership rates are rapidly increasing, with 14.6% in 2011 and 60.9% in 2017, and it is especially high among youth, with 79.5% ownership among 13- to 19-year-olds and over 90% among 20- to 30-year-olds [7].

A smartphone, compared to a traditional mobile phone (primarily used for telephoning/emailing purposes), is a device that provides high accessibility to the internet through the enrichment of social networking systems (SNS) and application ("app") functions. With widespread smartphone usage, internet addiction problems may be shifting from those that were PC-usage-related to those smartphone-usage-related, which can be used at any time and place. Therefore, fully evaluating this problem with an internet addiction scale created 20 years ago may not be possible.

Smartphone overuse is considered to be "the occurrence of daily life disturbance through smartphone overuse as well as withdrawal symptoms such as anxiety and impatience when smartphone cannot be used [8, 9]." Further, it is correlated with problematic internet use, with many similarities in their structural concepts [8]. However, smartphone overuse is unique because it is an addiction to portable devices [8].

The adolescents of smartphone overuse is rapidly increasing, as is the seriousness of online gaming addiction [2, 10, 11]. Thus, in 2018, the World Health Organization International Classification of Diseases (ICD)-11 designated internet gaming disorder as a mental disease [12]; it is defined as the continuation or repetitive gaming behavior (online or offline) with the persistence of the following three symptoms for at least 1 year: impaired control over gaming; increased priority given to gaming over all other interests in life; and continuation of gaming even with the occurrence of negative consequences to their social life [13]. This disorder presents comparable symptoms to pathological gambling and similar addictions.

Additionally, smartphone overuse has detrimental effects on health [2, 14, 15]; it became a concern because it can generate sleep disorder, lack of exercise, and poor academic performance [16], and is also related to mental health problems such as self-control, anxiety, depression, and dysfunctional impulsivities [17, 18]. Problematic smartphone users also have multiple psychiatric symptoms [19], that is, it coexists with those symptoms. Further, excessive technology use is a maladaptive coping strategy used to deal with depressive and anxious symptoms [19]. There is a bi-directional relationship between mental disorders (e.g., depression) and smartphone overuse [18].

To our knowledge, few studies in Japan have investigated internet gaming disorder or smartphone overuse utilizing an international scale. In Korea, a Smartphone Addiction Scale (SAS) was developed [8]: The questions of SAS comprise items from a modified internet addiction scale [20], and items unique to smartphone addiction devised by specialists in behavioral addiction. Further, the validity and reliability of this scale have been validated [8]. SAS or SAS-short version has been translated into various languages such as German [21], Spanish and French [22], Turkey [23], Malaysia [24], Arabic [25], and Portuguese [26]. However, the scale has not yet been translated to Japanese, so it cannot be utilized in Japan. Therefore, we planned the development of a Japanese version of SAS (SASJ). This study aimed to evaluate the reliability and validity of the SASJ among Japanese youths and investigate factors related to smartphone overuse.

Methods

Creating the SASJ

Permission to translate the scale was obtained from its author [8]. The translation was performed based on the World Health Organization recommendations [27]. To create the SASJ, a Japanese translator translated the text from English to Japanese; then, it was examined from a cultural, linguistic, and medical

perspective by the authors and specialists in two fields (i.e., addiction research and clinical practice; linguistics and translation). These specialists acted as expert judges to qualitatively assess each item.

After this examination, the text was reverse-translated by two bilingual American translators, and the resulting text was sent to the original creator for evaluation and was approved. Subsequently, the questionnaire was applied in a pilot study conducted with a few adults and junior high/high school students to verify the Japanese translation.

Study design and setting

We sent a letter to the principal of each school asking for their cooperation, along with the same number of questionnaires and return envelopes as the number of students enrolled at the school. After agreeing, they asked each class teacher to inform students about all aspects of the survey, its purpose, that participation was voluntary, all responses would be confidential and privacy would be protected. After questionnaire completion, students returned them to our department using the provided return envelopes. The survey was conducted from November to December 2018.

Participants

In total, 1,086 participants, aged between 15–24 years (median age, 17 years), were recruited from one high school (n = 1,050) and one vocational school (n = 83) in a suburban area of central Japan. Participants comprised high school students from 10th to 12th grade, and first-year vocational school students.

Measures

SAS. The original SAS is a self-administered scale for smartphone addiction composed of six factors (daily-life disturbance, positive anticipation, withdrawal, cyberspace-oriented relationship, overuse, and tolerance) and 33 items rated on a six-point Likert scale from 1–6 (strongly disagree-strongly agree) [8]. The total score ranges from 33–198.

Patterns of smartphone usage. We asked questions on whether participant had a smartphone and on smartphone usage duration/day on weekends, primary contact person (family, real friends, virtual friends), home smartphone usage rules, and average monthly smartphone usage fees. As for being a “smartphone zombie,” which meant using a smartphone while walking and not paying attention to one’s surroundings, we asked “Did you use a smartphone while walking in the past 30 days?” with five response options: “never,” “seldom,” “sometimes,” often,” and “always” (“often” and “always” were considered affirmative answers). We also asked questions on smartphone use services such as internet search, email, free communication apps, SNS, blogs, online games, and videos [5].

GHQ-12. The General Health Questionnaire-12 (GHQ-12) is a self-administered questionnaire designed as a screening tool for mental diseases [28]. It consists of two elements, “depression and anxiety” and “reduction of positive emotions”, and a total of 12 items (six items per element). Four answer options are provided for each item; two options represented symptomatic absence (0 points), and the other two options represented symptomatic presence (1 point). This scale ranges from 0–12 points with higher total scores indicating poorer mental health. Previous studies set the cut-off value for the GHQ-12 to 4 points, and regarded a person with a score of 4 points or higher as having poor mental health [29].

Data analyses

First, the baseline characteristics of the study participants were assessed. We described age structure, smartphone usage pattern, usage amount, and contact person by gender.

Second, exploratory factor analysis investigated construct validity and the maximum likelihood promax with Kaiser Normalization. Data factorability was assessed by the Kaiser-Meyer-Olkin test for sampling adequacy and supported by Bartlett’s test of sphericity to verify the suitability of data for factor analysis. Based on the Guttman-Kaiser rule, factors with eigenvalue large than 1 are retained [30].

Third, confirmatory factor analysis was performed to evaluate the factor structure of this scale. To find the best factorial solution, we used basic overall goodness-of-fit measures to assess the compatibility of the purpose model according to six criteria: Chi-square over degree of freedom (χ^2 /df), Goodness of Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Comparative Fit Indexes (CFI), Tucker Lewis Index (TLI), and Root Mean Square Error Approximation (RMSEA).

Fourth, to test the internal consistency of the SASJ, Cronbach’s alpha correlation coefficients were calculated [31].

Fifth, to evaluate re-test reliability, the intraclass correlation coefficient ($ICC_{3,1}$; two-way mixed, absolute agreement, single measurement) was obtained from a subgroup of 81 students from the participating vocational school.

Finally, to evaluate associated factors of smartphone overuse, we used the Spearman correlation coefficient to investigate the relationship between smartphone addiction scores and variables such as age, gender, smartphone usage duration/day on weekends, smartphone use services, primary contact, average monthly smartphone usage fees, home smartphone usage rules, GHQ-12 scores, and smartphone zombie. All analyses were performed using SPSS version 25.0 and AMOS 23.0 for Windows with the statistical significance set at $p < 0.05$.

Results

Participants’ characteristics

In total, 1,072 completed questionnaires were returned; however, 35 questionnaires were excluded owing to not owning a smartphone; therefore, data from 1,037 questionnaires were analyzed, with an effective response rate of 96.7%. Of the study population, 97% owned a smartphone (Table 1); 30.6% of male and 31.3% of female used smartphones for more than 5 hours/day on weekends, and most participants used internet search communication apps and SNS. Regarding to average SASJ score, males scored 78.0 ± 27.1 and females scored 88.7 ± 28.6. Gender differences were significant in this study ($p < 0.001$).

Table 1. Participants' baseline characteristics

	Male(N = 631)		Female(N = 406)	
	N	%	N	%
Age				
15–16 years	279	44.2	151	36.9
17–18 years	305	48.3	165	41.0
19–24 years	47	7.5	90	22.1
Smartphone usage duration/day on weekends				
Less than 2 hours	106	16.8	65	16.0
2–3 hours	84	13.3	51	12.6
3–5 hours	240	38.0	160	39.4
More than 5 hours	193	30.6	127	31.3
Unknown	114	18.1	4	1.0
Smartphone use services (multiple answers allowed)				
Internet search	528	83.7	349	86.0
E-mail	211	33.4	192	47.3
Communication apps	614	97.3	406	100.0
Blogs	101	16.0	42	10.3
SNS	475	75.3	347	85.5
Online games	484	76.7	146	36.0
Videos	521	82.6	344	84.7
Primary contact (multiple answers allowed)				
Family	468	74.2	338	83.3
Real friends	590	93.5	396	97.5
Virtual friends	77	12.2	65	16.0
Home smartphone usage rules	192	30.4	136	33.5
Mental health (GHQ-12)				
Poor (4–12)	179	28.4	168	26.6
Good (0–3)	387	61.3	212	33.6
Unknown	65	10.3	26	4.1
Smartphone zombie	128	20.3	119	29.3
Average monthly smartphone usage fees (Japanese yen)				
Less than 3,000	136	21.6	60	14.8
3,000–4,999	50	7.9	42	10.3
5,000–6,999	154	24.4	103	25.4
7,000–9,999	96	15.2	70	17.2
10,000–14,999	66	10.5	59	14.5
More than 15,000	18	2.9	9	2.2
Unknown	111	17.6	63	15.5

CI: confidence interval; SNS: social networking systems; GHQ-12: General Health Questionnaire-12

Smartphone Zombie: using a smartphone while walking and not paying attention to one's surroundings.

Participants who did not have smartphones were excluded from the analysis.

Reliability and validity of SASJ

Table 2

shows the exploratory factor analysis of the SASJ. The six factors corresponding to the SAS subscales were referred to as “withdrawal,” “cyberspace-oriented relationship,” “overuse and tolerance,” “preoccupation,” “daily life disturbance,” and “positive anticipation.” The corrected item-total correlation coefficients ranged from 0.42 (item 1) to 0.72 (item 30). Deletion of any individual items did not reveal changes in the scale internal consistency.

Table 2. Exploratory factor analysis of the Smartphone Addiction Scale Japanese version

Question No:	Components				
	Withdrawal	Cyberspace-oriented relationship	Overuse and Tolerance	Preoccupation	Daily life disturbance
Item08	0.61				
Item10	0.78				
Item12	0.60				
Item13	0.71				
Item15	0.52				
Item16	0.56				
Item18	0.29				
Item22	0.41				
Item20		0.40			
Item21		0.92			
Item23		0.82			
Item26		0.85			
Item27		0.37			
Item28			0.26		
Item29			0.59		
Item30			0.56		
Item31			0.91		
Item32			0.95		
Item33			0.53		
Item11				0.89	
Item14				0.95	
Item17				0.58	
Item19			0.20	0.21	
Item24		0.29		0.32	
Item25		0.30		0.34	
Item01					0.39
Item02					0.47
Item03					0.77
Item04					0.72
Item05					0.80
Item06					
Item07					
Item09					
Eigenvalue	11.76	1.82	1.47	0.88	0.73
Variance (%)	35.63	5.53	4.45	2.67	2.21
Extraction Method: Confirmatory exploratory analysis					
Rotation Method: maximum likelihood promax with Kaiser Normalization					

Table 3
shows the confirmatory factor analysis of the SASJ. Kaiser-Meyer-Olkin tests showed the sampling adequacy as 0.95 and was supported by a significant value on Bartlett's test of sphericity ($p < 0.01$).

Table 3. Confirmatory factor analysis of the Smartphone Addiction Scale Japanese version

	Secondary Factor Analysis						
	Secondary factor	Withdrawal	Cyberspace-oriented relationship	Overuse and Tolerance	Preoccupation	Daily life disturbance	Positive anticipation
Item08	0.93	0.69					
Item10		0.71					
Item12		0.76					
Item13		0.75					
Item15		0.73					
Item16		0.73					
Item18		0.61					
Item22		0.71					
Item20	0.63		0.82				
Item21			0.81				
Item23			0.84				
Item26			0.51				
Item27			0.49				
Item28	0.88			0.47			
Item29				0.75			
Item30				0.81			
Item31				0.78			
Item32				0.63			
Item33				0.64			
Item11	0.72				0.54		
Item14					0.51		
Item17					0.52		
Item19					0.76		
Item24					0.79		
Item25					0.78		
Item01	0.85					0.58	
Item02						0.67	
Item03						0.61	
Item04						0.51	
Item05						0.78	
Item06	0.77						0.70
Item07							0.78
Item09							0.81

Table 4

shows the reliability analysis of the SASJ. The SASJ model with the above six factors manifested an adequate fit outcome $\chi 2$ statistics of 3086.48 (degree of freedom = 489, $p < 0.01$), with a ratio of $\chi 2/df$ value being 6.3. GFI was 0.837 and AGFI was 0.817, showing a moderate fit. CFI was 0.853 and the TLI was 0.41, showing a moderate fit. RMSEA was 0.071 (less than 0.08), showing good fit. All canonical correlations showed values of less than 1.00, signaling that discriminant validity was tested and acceptable. At factor loading, the standard coefficient estimated was good, as it surpassed the accepted level of 0.30 with a $p < 0.01$.

Table 4. Reliability analysis of the Smartphone Addiction Scale Japanese version

	Mean	Standard deviation	Scale mean if item deleted	Scale variance if item deleted	Corrected item-total correlation	Cronbach`s α if item deleted
Item 1	1.70	1.11	80.47	769.99	0.42	0.94
Item 2	2.46	1.43	79.71	754.74	0.51	0.94
Item 3	2.80	1.59	79.38	752.69	0.48	0.94
Item 4	2.32	1.46	79.84	759.99	0.43	0.94
Item 5	2.42	1.37	79.76	750.53	0.59	0.94
Item 6	2.85	1.49	79.35	740.22	0.67	0.94
Item 7	3.23	1.50	78.96	743.68	0.62	0.94
Item 8	2.02	1.18	80.17	756.74	0.61	0.94
Item 9	2.96	1.58	79.24	745.23	0.57	0.94
Item 10	1.95	1.16	80.23	757.54	0.59	0.94
Item 11	3.42	1.61	78.76	739.61	0.62	0.94
Item 12	2.20	1.25	79.98	750.82	0.65	0.94
Item 13	2.14	1.24	80.05	751.79	0.64	0.94
Item 14	3.21	1.70	78.96	735.20	0.64	0.94
Item 15	2.10	1.31	80.08	748.06	0.66	0.94
Item 16	1.97	1.17	80.21	752.40	0.67	0.94
Item 17	2.75	1.59	79.42	737.84	0.66	0.94
Item 18	2.45	1.40	79.73	748.77	0.60	0.94
Item 19	2.44	1.53	79.73	751.20	0.52	0.94
Item 20	2.94	1.52	79.24	751.15	0.52	0.94
Item 21	1.78	1.08	80.41	766.91	0.49	0.94
Item 22	2.04	1.31	80.13	747.08	0.67	0.94
Item 23	1.66	1.01	80.52	767.43	0.51	0.94
Item 24	2.59	1.54	79.60	751.73	0.51	0.94
Item 25	2.57	1.60	79.61	746.46	0.55	0.94
Item 26	1.73	1.05	80.45	765.76	0.53	0.94
Item 27	2.49	1.45	79.69	755.68	0.49	0.94

Table 4. Reliability analysis of the Smartphone Addiction Scale Japanese version						
Item 28	2.77	1.78	79.41	751.99	0.43	0.94
Item 29	3.55	1.63	78.64	738.43	0.63	0.94
Item 30	2.88	1.54	79.31	734.72	0.72	0.94
Item 31	2.62	1.50	79.55	743.34	0.62	0.94
Item 32	2.97	1.63	79.19	754.72	0.44	0.94
Item 33	2.40	1.51	79.78	747.84	0.57	0.94

Table 5

shows the correlation of the initial subscales and Cronbach's alpha coefficients. The entire Cronbach's alpha was 0.94 for the 33 items in the SASJ. Subscale correlations ranged from, r = 0.37; p < 0.01, to, r = 0.88; p < 0.01, and higher Cronbach's alpha coefficients were shown, above 0.82. Finally, the SAS showed good reliability for test-retest scores ($ICC_{3,1}$=0.92; 95% confidence interval [CI] 0.88–0.95) in the subgroup with 81 vocational school students.

Table 5. Total-item correlation, subscale correlation, and Cronbach's alpha coefficients

	Withdrawal	Cyberspace-oriented relationship	Overuse and Tolerance	Preoccupation	Daily life disturbance	Positive anticipation	SASJ total score	Cronbach`s α
Withdrawal	(n.a)							0.82
Cyberspace-oriented relationship	.62**	(n.a)						0.86
Overuse and Tolerance	.58**	.41**	(n.a)					0.84
Preoccupation	.72**	.51**	.62**	(n.a)				0.83
Daily life disturbance	.52**	.37**	.59**	.49**	(n.a)			0.85
Positive anticipation	.67**	.43**	.54**	.61**	.49**	(n.a)		0.85
SASJ total score	.88**	.68**	.81**	.85**	.72**	.77**	(n.a)	0.94
GHQ-12	.25**	.20**	.21**	.18**	.25**	.27**	.27**	

GHQ-12: General Health Questionnaire-12; SASJ: SAS Japanese version; SAS: Smartphone Addiction Scale

All scores were calculated by Person`s correlation efficient.

Missing values were excluded.

**p < 0.01

Factors associated with smartphone overuse

Table 6 shows the factors associated with smartphone overuse. Factors that showed significant correlations with smartphone overuse were gender (r = .173; p < 0.01), smartphone usage duration/day on weekends (r = .340; p < 0.01), virtual friends contact (r = .178; p < 0.01), mental health (r = .212 p < 0.01), and smartphone zombie (r = .262; p < 0.01). Most smartphone services such as communication apps (r = .058) and online games (r = .016) were weakly or nonsignificantly associated with smartphone overuse.

Table 6. Factors related to smartphone overuse

	1	2	3	4	5	6	7	8	9	10	11	12	13
SAS total scores	(n.a)												
Demographics													
Gender	.173**	(n.a)											
Age	.035	.136**	(n.a)										
Duration of smartphone use/day on weekends	.340**	.011	.096**	(n.a)									
Smartphone use services													
Internet search	.055	.023	.038	.084**	(n.a)								
E-mail	.122**	.132**	.111**	.067*	.256**	(n.a)							
Communication apps	.058	.096**	.053	.083**	.284**	.133**	(n.a)						
Blogs	.102**	-.089**	.006	.129**	.133**	.207**	.032	(n.a)					
SNS	.174**	.112**	.070*	.192**	.262**	.191**	.216**	.146**	(n.a)				
Online games	.016	-.401**	-.016	.177**	.193**	.099**	.124**	.197**	.175**	(n.a)			
Videos	.132**	.012	-.022	.186**	.278**	.110**	.172**	.132**	.217**	.209**	(n.a)		
Primary contact													
Family	-.004	.098**	.047	-.066*	.146**	.095**	.113**	.000	.078*	.042	.087**	(n.a)	
Real friends	.023	.072*	-.017	-.011	.084**	.028	.174**	-.028	.120**	-0.01	.073*	.063*	(n.a)
Virtual friends	.178**	.053	.006	.190**	.102**	.104**	.062*	.153**	.165**	.068*	.091**	-.015	.017
Rules on smartphone use at home	.067*	-.049	.091**	.117**	.047	.006	.005	.035	.013	.028	.069*	-.111**	-.018
Mental health (GHQ-12)	.212**	.134**	.011	.073*	.015	.039	.011	-.014	.029	-.05	.089**	-.021	-.012
Smartphone zombie	.262**	.082*	-0.01	.166**	-.012	.021	-.032	.054	.116**	-.006	.022	-.033	.036
Average monthly smartphone usage fees	.145**	.093**	.101**	.047	.050	.082*	.003	.055	.100**	.015	-.007	-.026	.006

** p<0.01, * p<0.05

SAS: Smartphone Addiction Scale; SNS: Social networking systems; GHQ-12: General Health Questionnaire-12;

Smartphone zombie: using a smartphone while walking and not paying attention to one's surroundings

Gender was coded as 0 (male) and 1 (female); Age was coded as 0 (15-16 years), 1 (17-18 years), and 2 (19-24 years);

Duration of smartphone use/day on weekends was coded as 0 (Less than 2 hours), 1 (2-3 hours), 2 (3-5 hours), and 3 (More than 5 hours).

Average monthly smartphone usage fees (Japanese yen) was coded as 0 (Less than 3,000), 1 (3,000-4,999), 2 (5,000-6,999), 3 (7,000-9,999), 4 (10,000-14,99 and 5 (More than 15,000).

Discussion

This was the first study to investigate smartphone overuse in Japanese youth using the SASJ. The SASJ showed good reliability and validity, so it is an appropriate questionnaire to examine smartphone overuse in youths; female gender, long smartphone usage duration, poor mental health, contact with virtual friends, and being a smartphone zombie were associated with smartphone overuse.

The SASJ exhibited good internal consistency; Cronbach's alpha coefficient for the total scale was 0.94, and the respective coefficients for the six factors were above 0.83. The test-retest reliability values were found to be similar to those of the original, Malay, and the Arabian SAS versions [8, 24, 25]. Thus, the SASJ is as good as the other language versions.

The six dominant components that explained a large proportion of the variability of the SASJ were similar to those of the original SAS. The components in the original version were “daily life disturbance,” “positive anticipation,” “withdrawal,” “cyberspace-oriented relationship,” “overuse,” and “tolerance.” In this study, the changes were: “overuse and tolerance” became one component instead of two, and we added the “preoccupation” component. Not all factors obtained in this factor analysis matched those of the original and/or other languages’ version [8, 24, 25]. The possible reasons could be: First, this may reflected age differences; our sample was younger (median age 17 years) than the Korean (26.1 ± 6.0 years), Malay (21.7 ± 1.1 years) and Arabian samples (27.4 ± 6.4 years) [8, 24, 25]. Second, the translation may have changed the original SAS meaning; in ethnicity, Japan is similar to Korea and East Asia, whereas cultural differences are profound and may have influenced the results. Third, our sample background was relatively more homogenous (high-school and vocational students) than that of the original version (wide range of occupations and educational levels).

Our results showed that SASJ scores were associated with the female gender. Corroborating, the risk of engaging in smartphone overuse is higher among females than males [8, 32–34]. However, males have higher risks of developing smartphone overuse than females [35]. Thus, gender differences may owe to sociocultural factors, potential confounding factors, and study methodology.

Results showed that smartphone usage duration was strongly associated with smartphone overuse, consistent with previous studies [21, 36–38]. Correlating, smartphone usage duration presented the strongest direct effects on smartphone overuse [37]. Further, adolescents with higher smartphone usage and for longer durations were aware of their addictive behavior and did not consider it problematic [21, 38]. Adolescents’ awareness over their problematic behaviors may a key determinant regarding smartphone overuse prevention.

Our study revealed that smartphone overuse was positively related to online friendship and unrelated to real friendship; corroborating, excessive chat room users constitute one of the Internet addiction groups [39]. For them, the Internet is a major source of social/interpersonal rewards, implying potential addiction to virtual relationships and communication [39]. Smartphone overuse and preference to communicate with virtual friends may demonstrate youths’ tendency to seek virtual friendships, and this association between the first and the latter may be bidirectional: Youth who prefer online friendships may experience more conflicts in the offline world; they may ignore offline friends and cultivate their tendency to overuse the virtual world through the smartphone. Besides, youth who are prone to smartphone overuse may have some reasons to spend a lot of time online; they may be looking for virtual friends to get the social support they do not find in the real world. Longitudinal research is needed to investigate these associations.

Youth studies show an important association between smartphone overuse and psychological and psychiatric problems [17, 18]. In this study, as expected, poor mental health status was positively associated with smartphone overuse. There may be a bi-directional relationship between mental disorders and smartphone overuse [18]. Thus, smartphones may worsen the status of - and be particularly attractive to -people with poor mental health.

Being a smartphone zombie was moderately related to smartphone overuse, implying that individuals get so absorbed in using their smartphones that, eventually, they are unable to cease their behavior while in transit. Being a smartphone zombie is caused by the need to continuously look at the screen to be able to instantly respond to messages or to check the transit progress on a map app. Moreover, smartphones require screen touch to input information, which may also be a cause of smartphone zombies.

Our results showed that smartphone applications were weakly related to smartphone overuse, unlike previous studies [14, 40]. Regarding the reason, many youths used the services listed in the questionnaire, and the differences between service usage in relation to smartphone overuse could not be extracted because the questions did not survey which service was mostly used. Future research should investigate the association between smartphone overuse and the usage duration of different app types by using separate apps that allow for the identification of usage duration by smartphone service type.

Our study has several limitations. First, it was conducted in a specific area of central Japan and the demographic characteristics of the study population were unbalanced. Therefore, it is difficult to generalize the results. Future studies should include developed and semi-developed demography and areas to obtain an insight on smartphone overuse and addictions led by socio-financial situations. Second, we adopted a self-administered questionnaire format. Thus, for questions such as smartphone usage time, we could have yielded more robust findings if we had chosen an approach that could validate the responses, such as an application to confirm usage time. Third, we did not take lifestyle factors (smoking or drinking alcohol) or sociological data (socioeconomic status or parents’ academic history) into consideration. Such factors may have shaped participants’ smartphone overuse, so their influence should be verified. Fourth, there is no diagnostic criteria for smartphone overuse, so it is difficult to determine the cut-off value; very few medical professionals in Japan can diagnose smartphone overuse, and the reliability/validity of the Japanese version of an internet addiction scale have yet to be validated. Therefore, we could not report the prevalence of smartphone overuse.

Despite the above limitations, our study provides important information on smartphone usage in Japanese youth. The SASJ is a reliable and valid questionnaire that can be used to screen for high risk of smartphone overuse in Japanese youth.

Conclusions

This was the first survey on smartphone overuse to utilize the SASJ. We found that female gender, long smartphone usage duration, poor mental health, contact with virtual friends, and being a smartphone zombie are related to smartphone overuse in the Japanese youth. Future studies should extend the survey area to include the nationwide population, other age groups, examine additional factors that may be related to smartphone overuse and consider intervention programs to prevent it.

Abbreviations

AGFI

Adjusted Goodness of Fit Index
app
application
CFI
Comparative Fit Indexes
GFI
Goodness of Fit Index
GHQ-12
The General Health Questionnaire-12
$ICC_{3,1}$
intraclass correlation coefficient
ICD
International Classification of Diseases
RMSEA
Root Mean Square Error Approximation
SAS
Smartphone Addiction Scale
SASJ
Japanese version of SAS
SNS
social networking systems
TLI
Tucker Lewis Index

Declarations

Ethics approval and consent to participate

The study protocol was approved by the Ethical committee of the Nihon University School of Medicine (Ref. number: 30-11-0). All procedures performed in this study involving human participants were in accordance with the 1964 Helsinki declaration and its later amendments. The written informed consent was obtained from participants and parents or guardians for participants under 16 years old. The data collection was also approved by the headmasters of the schools selected for this study. Participants were informed that the survey was totally voluntary.

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

Competing interests

No competing financial interests exist.

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Author information

Affiliations

Division of Public Health, Department of Social Medicine, Nihon University School of Medicine, 30-1 Oyaguchi-kamimachi, Itabasi-ku, Tokyo 173-8610, Japan

Yuichiro Otsuka, Yoshitaka Kaneita, Osamu Itani, & Yuuki Matsumoto

Authors' contributions

YO and YK designed the study. YO analyzed the data and wrote the initial draft of the paper. YO, YK, OI, and YM contributed to the interpretation of the data and writing of the manuscript. All authors critically reviewed the draft and helped revise the manuscript. All authors read and approved the final manuscript.

Corresponding author

Correspondence to Yuichiro Otsuka.

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