Psychometric testing of three Chinese online-related addictive behavior instruments among Hong Kong university students

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Abstract

Objective: To validate the Chinese version of the nine-item Internet Gaming Disorder Scales- Short Form (IGDS-SF9), Bergen Social Media Addiction Scale (BSMAS), and Smartphone Application-Based Addiction Scale (SABAS) among Hong Kong university students. **Participants and Methods:** Participants aged between 17 and 30 years participated in the present study (n=307; 32.4% males; mean [SD] age=21.64 [8.11]). All the participants completed the IGDS-SF9, BSMAS, SABAS, and the Hospital Anxiety and Depression Scale (HADS). Confirmatory factor analyses (CFAs) were used to examine the factorial structures and the unidimensionality for IGDS-SF9, BSMAS, and SABAS. **Results:** CFAs demonstrated that the three scales were all unidimensional with satisfactory fit indices: comparative fit index = 0.969 to 0.992. In addition, the IGDS-SF9 and BSMAS were slightly modified based on the modification index in CFA. **Conclusions:** The Chinese IGDS-SF9, BSMAS, and SABAS are valid instruments to assess the addiction levels of internet-related activities for Hong Kong university students.

Keywords: online addiction; gaming addiction; smartphone addiction; social media addiction; addiction psychometrics

Introduction

As technology use has increased in recent decades, a great proportion of people are now using internet-based applications and platforms. A study by the US Pew Research Center [1] reported that across 21 emerging and developing countries, there was a prevalence of 54% internet use. For the well-developed countries, such as Canada and America, the percentage was even higher at 87% [1]. In Hong Kong, a similar prevalence rate has been reported. More specifically, according to the Census and Statistic Department of Hong Kong [2], in 2016, 79.5% of Hong Kong households had accessed the internet via a home personal computer and 87.5% of people had used the internet. In addition to internet use, smartphone usage has shown large increases among developing and developed countries with around 60% to 95% of young adults having a smartphone [3]. In Hong Kong, 99.3% of young adults, aged between 15 to 24 years, were reported to own a smartphone [2], and about three-quarters of adults had used their smartphones to access social networking sites (e.g., *Facebook* and *Twitter*) [1].

In addition to accessing and using social networking sites, internet gaming is another online activity that adolescents commonly engaged in [4-5]. Given the large increase in individuals engaged in online activities many studies have claimed that a small minority of such individuals may experience problematic and/or addictive use of online applications such as gaming and social networking. Consequently, the concept of non-substance related addictions has gained a growing interest [6], and the umbrella term Internet Addiction (IA) has been applied and defined. More specifically, IA indicates an inability to control internet use, and eventually results in marked distress and/or significant impairment in an individual's social functioning, occupational and/or educational difficulties, financial problems and/or relationship problems [7]. Although IA has not been classified as a mental health disorder in the latest (fifth) edition of the *Diagnostic and Statistical Manual of Mental Disorders* (DSM-

5), the DSM-5 identified a condition related to IA – internet gaming disorder (IGD) – as a condition for further study [8].

Although there are now many instruments that assess the concepts of IA and IGD, there are very few in Chinese, which given the 14 billion Chinese people worldwide are much needed. Although many aspects of IA and IGD have been investigated [9,10], there is a lack of Chinese research understanding of addictive behaviors related to internet and smartphone use among adults, especially for university students. Therefore, the validation of an ultra-brief instrument (with less than 10 items) will greatly reduce the administrative burden and the time cost of conducting such assessment. A brief instrument (i.e., the Chinese Internet Gaming Disorder Scale; C-IGDS) was recently developed in Hong Kong [11]. The C-IGDS showed promising psychometric properties. However, Sigerson et al. [11] did not focus on emerging and young adults (18-30 years old), who are the most frequent internet users [2]. More specifically, university students who are frequent internet and smartphone have freedom and autonomy to access internet-based applications. Thus, the psychometric properties of internet-related instruments should be further examined in this population. Furthermore, Sigerson et al. [11] did not explore the relationship between IGDS-SF9 and other related IA-related behaviors (e.g., social media addiction, smartphone application addiction).

In order to fill up the literature gap, the present study validated the following instruments using a sample typically classified as frequent internet users: the nine-item Internet Gaming Disorder Scales- Short Form (IGDS-SF9), the Bergen Social Media Addiction Scale (BSMAS) and the Smartphone Application-Based Addiction Scale (SABAS).

Method

Study design and procedure

Data were collected from university students (including postgraduates and undergraduates) aged between 17 and 30 years in Hong Kong. Through convenience sampling, three instruments (IGDS-SF9, BSMAS, and SABAS) were used to examine their psychometric properties in a cross-sectional design. For the validation of the three instruments, a standard procedure was applied [12] with the beginning of forward translations for the aforementioned instruments. The translations were carried out by two bilingual Master's students studying in occupational therapy who were fluent in Chinese and English. The forward translations were done independently and merged into one forward translation after reconciliation together with an assistant professor in occupational therapy. The back-translations were then carried out by a native English speaker who studied medicine and was fluent in Chinese. The back-translations were compared with all three original versions of the IGDS-SF9, BSMAS, and SABAS by a panel (a pediatrician, a psychometrician, a psychologist, a social worker, and a public health expert all with doctorate degree) to ensure the linguistic equivalence. After confirming the linguistic validity of the translated instruments, a pilot study (n=16) was conducted to test the readability of the translated items using a 4-point scale (1: totally non-understandable, 4: totally understandable). The demographic constitution of the pilot participants included 2 males and 2 females in each age group from 15-20, 21-30, 31-40 and 41-50 years (age range between 18 and 49 years). The results of the readability in the pre-test indicated that each item has a median of 4 and a mean between 3.25 and 4.

Sampling

The study was approved by the ethic committee of the Hong Kong Polytechnic University (IRB ref: HSEAR 20171212001) and targeted participants (young adults aged 17 to 30 years) were asked to participate in the study via an online survey. A hyperlink which contained the study background information, informed consent, and the aforementioned

psychometric scales were provided to the target participants. They were asked to complete the online questionnaires after accessing the hyperlink. The inclusion criteria for participants were that they had to: (i) understand written Chinese in traditional characters; (ii) understand spoken Chinese in Cantonese for Hong Kong participants; (iii) have had their own smartphone over three months; (iv) have access to the internet; and (v) have sufficient cognitive ability to complete all the psychometric scales. Individuals who self-reported that they were diagnosed with any mental health problems (e.g., schizophrenia, depression or anxiety) or with any upper limb disability were excluded.

Measures

Internet Gaming Disorder Scale - Short Form (IGDS-SF9). The IGDS-SF9 is a nine-item instrument assessing IGD, and was developed based on the IGD concept proposed in the DSM-5 [8]. The IGDS-SF9 is a self-report scale with a five-point Likert-type scale ranging from *Never* (score 1) to *Very often* (score 5). Higher scores on the IGDS-SF9 relate to a higher degree of problematic gaming use. A sample item of IGDS-SF9 is *"Do you systematically fail when trying to control or cease tour gaming activity?"* The IGDS-SF9 has a confirmed unidimensional structure and promising psychometric properties in several studies and different languages, including English [13-14], Portuguese [15], Italian [16], Persian [17], Polish [18], Albanian [19], and Turkish [20-21]. For example, the Cronbach's α for the IGDS-SF9 was 0.9 and test-retest reliability ranged from 0.79 to 0.91 in the study from Wu et al. [17].

Bergen Social Media Addiction Scale (BSMAS). The BSMAS is a six-item instrument developed by Andreassen et al. [22] to assess the risk of social media addiction, and was developed based on the six core components of addiction proposed by Griffiths [23] (i.e., salience, mood modification, tolerance, withdrawal conflict and relapse). The instrument adopts a five-point Likert-type scale ranging from *Very rarely* (score 1) to *Very often* (score

5). A higher score on the BSMAS relates to a greater risk of social media addiction. A sample item of BSMAS is *"How often during the last year have you felt an urge to use social media more and more?"* The unidimensionality and satisfactory psychometric properties of the BSMAS have been confirmed in different languages in diverse populations, including English [22], Italian [24], Persian [25], and Portuguese [26]. For example, in the study from Monacis et al. [24], the Cronbach's α was 0.97, and the concurrent validity was supported by IGDS-SF9 (r=0.76).

Smartphone Application-Based Addiction Scale (SABAS). The SABAS is a six-item instrument also based on the six core criteria of the addiction components model [27] to assess the risk of smartphone addiction. The instrument uses a six-point Likert-type scale from *Strongly disagree* (score 1) to *Strongly agree* (score 6). A higher score on the SABAS relates to a greater risk of smartphone addiction. A sample item of the SABAS is *"My smartphone is the most important thing in my life."* The unidimensionality of the SABAS has been found in English- and Hungarian-speaking online users [28-29]. Additionally, Cronbach's α was 0.81 in the study by Csibi et al. [28].

Hospital Anxiety and Depression Scale (HADS). The HADS is a widely used instrument to assess psychological distress in various social or medical contexts. The 14-item scale assesses two domains (anxiety and depression, comprising seven items for each domain). A four-point Likert-type scale (*"Yes, definitely"*, *"Yes, sometimes". "No, not much", and "No, not at all"*) is applied when using the HADS. A higher HADS score relates to higher levels of anxiety and/or depression. A sample question of the HADS is *"I can sit at ease and feel relaxed"* for anxiety, and "*I feel as if I am slowed down*" for depression. The two-factor structure of the HADS has been confirmed in Hong Kong adolescents [30] with acceptable Cronbach's alpha (0.79 for anxiety and 0.67 for depression).

Statistical analysis

All analyses were conducted with IBM SPSS Statistic version 23.0 (IBM Corp., Armonk, NY), and IBM SPSS AMOS graphic (IBM Corp., Armonk, NY). Descriptive statistics were used to delineate the participants' characteristics; Pearson's correlation was used to illustrate the relationships among the collected variables. Floor and ceiling effects were computed using percentages for the lowest and the highest scores on the IGDS-SF9, BAMAS and SABAS, and acceptable effects were having a percentage of <20.0% [31]. Internal consistency was demonstrated using Cronbach's α with >.7 considered satisfactory [32]. Corrected item–total correlation was computed with a value of >.4 considered acceptable [33].

Confirmatory factory analysis (CFA) with maximum likelihood estimator was applied to test the factorial structures for the three psychometric instruments. Based on the literature [17,24,28], all instruments should be unidimensional. Therefore, following fit indices were used to examine whether IGDS-SF9, BSMAS, and SABAS were unidimensional: a nonsignificant χ^2, the comparative fit index (CFI) > 0.9, the root mean square error of approximation (RMSEA) < 0.08, and the standardized root mean square residual (SRMR) <0.08 [34-35]. Moreover, a modification index (MI) that correlated item uniqueness was used for the instruments if unsatisfactory fit was found. More specifically, one pair of two item uniqueness was correlated once at a time until achieving satisfactory fit.

Results

As indicated by Table 1, the participants (N=307) had a mean age of 21.64 years (SD=8.11). Nearly one-third of the participants were males (32.4%), and only few of them were current smokers (2.0%). On average, the participants spent 5.29 hours (SD = 3.79) per day on their smartphone, 3.11 hours (SD=2.00) per day on social media, and 1.09 hours

(SD=1.81) per day on gaming. Additionally, their scores were 5.88 (SD=3.37) for anxiety and 5.18 (SD=2.84) for depression.

(Insert Table 1 here)

Because some of the fit indices of the CFA for IGDS-SF9 were unsatisfactory (CFI=0.944, TLI=0.926, RMSEA=0.100, SRMR=0.046), MI suggestion was adopted to modify the IGDS-SF9 model. Specifically, the uniqueness of Item 6 was correlated to that of Items 4 and 5. Finally, the modified IGDS-SF9 model had all fit indices satisfactory (CFI=0.969, TLI=0.955, RMSEA=0.077, and SRMR=0.041), except for the χ^2 test (χ^2 [*df*=25] =62.25; $p<0.001$). As for the BSMAS, some of the fit indices in the CFA were also unsatisfactory (CFI=0.914, TLI=0.857, RMSEA=0.131, SRMR=0.0524), and the uniqueness of Item 1 and that of Item 2 were correlated to improve the fit indices (CFI=0.981, TLI=0.964, RMSEA=0.066, SRMR=0.029, χ^2 [*df*=8]=17.06; p=0.029). As for the SABAS, all fit indices (CFI=0.992, TLI=0.986, RMSEA=0.034, SRMR=0.031, χ^2 [*df*=9] =12.07; p=0.21) were satisfactory without any modification to the structure (Table 2).

(Insert Table 2 here)

As for other psychometric properties at scale level, the three instruments had satisfactory ceiling effects (all were 0%), and acceptable or nearly acceptable floor effects (0% to 21%). The internal consistency was adequate for all instruments (Cronbach's α=0.903 for IGDS-SF9, 0.819 for BSMAS, and 0.751 for SABAS). Moreover, the IGDS-SF9 was significantly correlated with BSMAS (r=0.22) and SABAS (r=0.35). The BSMAS was significantly correlated with SABAS (r=0.54). Anxiety (r=0.17 with IGDS-SF9; 0.19 with BSMAS; 0.30 with SABAS) and depression (r=0.21 with IGDS-SF9; 0.18 with BSMAS; 0.22 with SABAS) were all significantly correlated to the three instruments. In anticipation, time spent on gaming was significantly correlated with IGDS-SF9 (r=0.33); time spent using

social media was significantly correlated with BSMAS (r=0.22); and time spent using a smartphone was significantly correlated with SABAS (r=0.19; Table 3).

(Insert Table 3 here)

In terms of the item properties in IGDS-SF9, all factor loadings derived from the CFA were significant with the range between 0.536 and 0.854. The corrected item-total correlations were between 0.527 and 0.724. For the BSMAS, all factor loadings derived from the CFA were significant with the range between 0.591 and 0.704. The corrected item-total correlations were between 0.549 and 0.631. For the SABAS, all factor loadings derived from the CFA were significant with the range between 0.331 and 0.790. The corrected item-total correlations were between 0.276 and 0.642 (Table 4).

(Insert Table 4 here)

Discussion

The present study demonstrated that the three internet-based questionnaires (IGDS-SF9, BSMAS, and SABAS) had satisfactory psychometric properties, including internal consistency, criterion validity, and construct validity among Hong Kong university students. Results of the present study are in line with the previous studies, which also showed that the IGDS-SF9 [13], BSMAS [23], and SABAS [28] are psychometrically robust. More specifically, all the previous findings [15-18,21] and the findings in the present study demonstrated that all the three instruments had a unidimensional structure.

IGDS-SF9

Although the internal consistency between findings in the present study and others are comparable [15-18], the present study revealed relatively high floor effects (21%) as compared with previous studies [11,17]. More specifically, another study using a Hong Kong population using C-IGDS showed the floor effect at 0.8%; one study on Iranian population using IGDS-SF9 also showed the floor effect at 0.8% [17]. A possible reason is that the

participants in the present study involved less in internet gaming. Indeed, the average hours spent on gaming were less in the present study (1.09 hours per day) than other studies (e.g., 1.57 hours per day in the participants of Sigerson et al. [11]; 2.57 hours per day in the participants of Wu et al. [17]).

Nevertheless, the unidimensional structure of IGDS-SF9 shown in the present study confirmed that of previous studies [21,36]. However, the uniqueness was correlated based on MI suggestion in the following paired items for this current study: Items 4 and 6; Items 5 and 6. It was postulated that the correlated uniqueness between Items 4 and 6 was because of a similar concept of "*unsuccessful in not engaging gaming activity*" shared by both items. In terms of the correlated uniqueness between Items 5 and 6, they may be correlated because Item 5 describes a possible reason (i.e., lost interests) for the content in Item 6 (i.e., continue gaming activity) [37].

BSMAS

The internal consistency and floor and ceiling effects of the BSMAS in the present study were comparable to other language versions [24,25,38]. In addition, similar to Lin et al. [39], results in the present study showed that the BSMAS had significant correlations with IGDS-SF9, anxiety, depression, and time spent using social media. For the CFA, the Italian BSMAS had the same practice as the present study in modifying the unidimensional structure: the uniqueness of Item 1 was correlated to that of Item 2. An explanation of the correlated uniqueness was given that "individuals characterized by high self-esteem, enjoyment in intimate relationships and in sharing feelings with others, may be lower at risk of becoming addicted to social networking (p.183)." [24].

SABAS

The internal consistency of the SABAS in the present study confirmed the findings of other SABAS studies [28,29]. Additionally, the criterion validity was confirmed through

significant correlations between the IGD-SF9, BSMAS, anxiety, depression and time spent using a smartphone. This is somewhat in line with previous research, where Csibi et al. [28] found the significant correlations between the SABAS and the other health instruments: Nomophobia Questionnaire, Brief Sensation Seeking Scale, the Deprivation Sensation Scale, and the Patient Health Questionnaire Depression Scale. However, Csibi et al. [28] indicated an inverse relationship between depression and excessive smartphone use. A possible explanation is that although active use of social applications via smartphone might be beneficial in lowering depressive symptoms [40], the excessive use of social applications in addition to the high population density in Hong Kong may create social overload, which in turn further increases the chance of depression [41].

Limitations

There are some limitations in the present study. First, no data were collected regarding when the participants began using social media or their smartphones. The information might have influenced the scores on the three instruments examined. Second, no information was collected regarding formal psychiatric diagnosis among the participants (i.e., diagnosis from their medical record). Instead, participants simply self-reported the diagnostic information. Therefore, the influences from psychiatric disorders cannot be excluded. Third, only young adults (and majority were from one university) were recruited. Consequently, the results of the present study may not be able to generalize to other age groups (e.g., retired people/ high school students). Finally, all data were self-report and are open to well-known biases including memory recall and social desirability.

Conclusion

Through standardized procedures in translation and the use of robust psychometrics, the present study concluded that Chinese IGDS-SF9, BSMAS, and SABAS are short, valid, reliable, and easy-to-use instruments for screening online related-addiction risk in a Chinese

population. All the items in the three instruments had relevant impacts on the scores, indicated by the significant factor loadings derived. Significant correlations were found among these scales, and between the scales and other external criteria (e.g., time spent on gaming, time spent using social media, and time using smartphone).

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Table 1. Participant characteristics

	Mean (SD) or n (%)
Age(Year)	21.64 (8.11)
Gender (male)	99 (32.4)
Time on smartphone (hours per day)	5.29 (3.79)
Time on using social media (hours per day)	3.11 (3.38)
Time on gaming (hours per day)	1.09 (1.81)
Current smoker (Yes)	6 (2.0)
Monthly income (HKD)	
<5,000	159 (52.5)
Between 5,000 and 10,000	16 (5.3)
>10,000	128 (42.3)
Anxiety score [a]	5.88 (3.37)
Depression score [a]	5.18 (2.84)

[a] Measured using Hospital Anxiety and Depression Scale

Table 2. Psychometric properties of the three scales in scale level

Psychometric testing	IGDS-SF9	BSMAS	SABAS	Suggested cutoff
Ceiling effects (%)	0%	0%	0%	<20
Floor effects (%)	21%	3.8%	0%	<20
Internal consistency (Cronbach's α)	0.903	0.819	0.751	>0.7
Confirmatory factor analysis (CFA)				
χ^2 (*df*)	62.25 (25)	17.06 (8)	12.07 (9)	Nonsignificant
Comparative fit index	0.969	0.981	0.992	>0.9
Tucker-Lewis index	0.955	0.964	0.986	>0.9
RMSEA	0.077	0.066	0.034	<0.08
SRMR	0.041	0.029	0.031	<0.08

IGDS-SF9= Internet Gaming Disorder Scale–Short-Form; uniqueness of item 6 was correlated to that of items 4 and 5 in the CFA
BSMAS= Bergen Social Media Addiction Scale; uniqueness of item 1 was correlated to that of item 2 in the CFA
SABAS= Smartphone Application-Based Addiction Scale; no modification indices were done in the CFA
RMSEA= Root-mean square error of approximation
SRMR= Standardized root mean square residual

Table 3. Correlation matrix among studied factors

	r (*p*-value)							
	1. IGDS-SF9	2. BSMAS	3. SABAS	4. Anxiety	5. Depression	6. Time on smartphone	7. Time on social media	8. Time on gaming
1.	--							
2.	0.22 (0.001)**	--						
3.	0.35 (<0.001)**	0.54 (<0.001)**	--					
4.	0.17 (0.007)**	0.19 (0.002)**	0.30 (<0.001)**	--				
5.	0.21 (0.001)**	0.18 (0.004)**	0.22 (<0.001)**	0.57 (<0.001)**	--			
6.	0.01 (0.85)	0.14 (0.02)*	0.19 (0.001)**	0.13 (0.02)*	-0.002 (0.97)	--		
7.	-0.01 (0.93)	0.22 (<0.001)**	0.06 (0.30)	0.05 (0.42)	-0.02 (0.70)	0.41 (<0.001)**	--	
8.	0.33 (<0.001)**	-0.10 (0.10)	0.02 (0.80)	-0.04 (0.52)	0.01 (0.82)	0.17 (0.003)**	0.33 (<0.001)**	--

*p<0.05
**p<0.01
IGDS-SF9= Internet Gaming Disorder Scale–Short-Form
BSMAS= Bergen Social Media Addiction Scale
SABAS= Smartphone Application-Based Addiction Scale

Table 4. Item properties and internal consistency

Scale or Item #	Item description	Mean (SD)	Factor loading[a]	Item-total correlation
IGD9-SF				
I1	Preoccupied with gaming behavior	2.10 (1.05)	0.826	0.756
I2	Feel more irritability, anxiety when reduce	1.18 (0.82)	0.854	0.803
I3	Spend more time to achieve pleasure	1.99 (0.97)	0.757	0.700
I4	Systematically fail when trying to control gaming activity	1.89 (0.90)	0.849	0.774
I5	Lost interests in previous hobbies	1.72 (0.83)	0.704	0.698
I6	Continued your gaming activity despite knowing it was causing problems	1.72 (0.87)	0.709	0.693
I7	Deceived about the amount of gaming activity	1.44 (0.72)	0.547	0.528
I8	Temporarily escape or relieve a negative mood	2.21 (1.05)	0.622	0.617
I9	Jeopardized or lost an important relationship	1.38 (0.75)	0.536	0.527
BSMAS				
B1	Salience	3.12 (1.05)	0.636	0.631
B2	Craving/tolerance	2.75 (0.96)	0.591	0.602
B3	Mood modification	2.11 (0.97)	0.647	0.566
B4	Relapse/loss of control	2.34 (1.00)	0.704	0.600
B5	Withdrawal	2.00 (0.90)	0.626	0.551

B6	Conflict/functional impairment	2.25 (0.99)	0.646	0.549
SABAS				
S1	Most important thing	4.03 (1.32)	0.331	0.276
S2	Conflicts have arisen	2.47 (1.21)	0.430	0.375
S3	Preoccupying myself	3.45 (1.34)	0.579	0.503
S4	Fiddle around more	3.59 (1.31)	0.722	0.595
S5	Irritable	2.91 (1.30)	0.636	0.565
S6	Fail to use less	2.95 (1.31)	0.790	0.642

IGDS-SF9= Internet Gaming Disorder Scale–Short-Form
BSMAS= Bergen Social Media Addiction Scale
SABAS= Smartphone Application-Based Addiction Scale
[a] Factor loadings were derived from confirmatory factor analysis