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The Smartphone Addiction Scale for University Students: Psychometric Characteristics and Factor Structure

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This study examined the psychometric characteristics, including validity and reliability indices, of a previously developed smartphone addiction scale. The scale was administered to 1986 university male (54%) and female students (46%). The proposed five-factor model was tested with a confirmatory factor analysis. Fit indices were acceptable for the five factors (time and overuse, psychological/social, health/physical, preoccupation, and technological). Correlation coefficients among items and dimensions were strong, suggesting good internal consistency. The scale also yielded good concurrent validity. However, the rating scale's fit to data was not acceptable. Moreover, the scale's reliability coefficients were high. The scale is recommended for use with other similar samples in other Middle Eastern countries. Future research should further evaluate the scale to promote its psychometric efficiency. We examined the psychometric properties of a smartphone addiction scale, - A confirmatory factor analysis supported a five-factor model, - University students (N = 1986) responded to the scale, - The scale was shown to be valid and reliable through several indices.

Key words: *smartphone addiction, confirmatory factor analysis, addiction behaviour, university students, psychometric characteristic*

1. Introduction

The smartphone is one of the great products to be birthed by the communication revolution of the past twenty years. Many people use smartphones, regardless of their age, sex, or social class. In addition, thanks to ever-increasing innovations, it is possible to install thousands of smartphone applications that serve several purposes: business, health, sports, design, games, social communication, scientific research, and so on.

Smartphone addiction (SA) refers to spending long hours using a smartphone, thus neglecting many other activities that an individual must complete. Adverse effects of SA include wasting time, neglecting other activities and people, and lethargy. SA in general refers to individuals' overuse of a smartphone and their inability to control its usage and preoccupation with it. Usage becomes compulsory, which results in adverse effects on various aspects of one's life: health, physical, psychological, social, and familial. Over dependency on smartphones is also an adverse effect of SA (Abo-Jedi, 2008). Notably, 48% of King Saud University students in Saudi Arabia were reported to be smartphone addicts (Aljomaa, Al-Qudah, Albursan, Bakhiet, & Abduljabbar, 2016), noting that the scale used in this study is the first in the Arabian countries.

There is a need for a measurement tool that has good psychometric characteristics to detect SA. Abo-Jedi (2008) made a great contribution to the field of SA and its assessment in the Arab world by developing a tool to probe SA among Saudi Arabia & Arab countries' university students. That tool was piloted with a sample of 480 university male and female students. An exploratory factor analysis of the completed scale yielded five factors that explained 57.68% of the total variance: inability to control time and overuse, overdependence on the smartphone for social communication, obsession and preoccupation with the smartphone, psychological dependency, and problems related to smartphone usage.

However, the exploratory factor analysis conducted by Choliz (2012) revealed that items loaded on three factors: abstinence, lack of control and problems, and tolerance and interference with other activities. Choliz also found significant sex differences in the three factors and the total score, revealing that women were more addicted than men were. In addition, significant age differences (12–14, 15–16, and 17–18 years) were also found: students aged 15–16 years showed greater SA than did students aged 12–14 years or 17–18 years for the total score and first and second factors; however, students aged 17–18 years showed greater SA than did students aged 12–14 years or 15–16 years on the third factor. Further, a positive correlation was found between the three factors and the total score, daily calls, daily SMSs, missed calls, times of the day, and dependency.

Kwon, Lee, et al. (2013) developed a SA tool and examined its psychometric characteristics with a sample of 197 individuals (64 men and 133 women, mean age = 26.06 years). An

exploratory factor analysis of the completed scale, Cronbach's alpha coefficients, t-tests, and correlation coefficients revealed that items loaded on six factors, which explained 60.99% of the total variance: daily life disturbance, positive anticipation, withdrawal, cyberspace-oriented relationship, overuse, and tolerance. Significant positive correlations were detected among the six factors of SA and respondents' performance on three scales of Internet addiction: Kimberly Young's scale, Visual Analogue Scale, and Y-scale. Correlation coefficients ranged between .315 and .607. The tool also yielded high internal consistency (α = .97 for the total scale). In addition, significant effects were found for education, occupation, and self-evaluation of smartphone usage in favor of smartphone addicts. Sex did not have significant effect.

Kwon, Kim, Cho, and Yang (2013) examined the validity of a short form of the SA Scale (SAS) with a sample of 540 adolescents (343 boys and 197 girls, mean age = 14.5 years). The researchers administered three tools: the SAS, the SA Proneness Scale, and the Korean Self-reporting Internet Addiction Short-form Scale. Data indicated that the SAS had high reliability and validity. Data also revealed significant effects concerning sex (girls were more addicted than were boys) and self-evaluation of smartphone usage in favour of smartphone addicts.

Demirci, Orhan, Demirdas, Akpinar, and Sert (2014) investigated the reliability and validity of a Turkish version of the SAS for youth (a version based on the scale developed by Kwon, Kim, et al., 2013) with a sample of 301 students (167 women and 134 men) studying medicine at Suleyman Demirel University. Exploratory factor analysis, correlation coefficients, and alpha coefficients revealed seven factors that explained 66.4% of the total variance: disturbing daily life and tolerance, withdrawal symptoms, positive anticipation, cyberspace-oriented relationships, overuse, social network dependence, and physical symptoms. Item loadings ranged from .349 to .824 and for the total scale, α = .95.

Lin, Chang, Lee, Tseng, Kuo, and Chen (2014) developed and validated the Smartphone Addition Inventory (SPAI) with 283 participants (260 men and 23 women, mean age = 22.9 years). Factor analysis, alpha coefficients, and correlation coefficients indicated that items loaded on four factors: compulsive behaviour, functional impairment, withdrawal, and tolerance. Correlations among the four factors ranged between .56 and .78, and for the total scale, α = .94.

Akin et al. (2014) established the reliability and validity of the Turkish version of the SAS developed by Kwon, Kim, et al. (2013) with a sample of 312 high school students (183 girls and 129 boys). Using a confirmatory factor analysis, the univariate structure of the scale was confirmed (χ^2 = 56.92, df = 31, root mean square error of approximation (RMSEA) = .052, NFI = .96, comparative fit index (CFI) = .98, IFI = .98, RFI = .94, GFI = .96, and SRMR = .040). The scale yielded a reliability coefficient of .88.

Fernandez (2015) examined the psychometric characteristics of the SAS developed by Kwon, Kim, et al. (2013) using Spanish and French respondents (N = 425, aged ≥ 18 years). Results revealed that the scale had high reliability (αs = .88–.90). An exploratory factor analysis revealed six factors: control, disruption, disregard, withdrawal, preoccupation, and tolerance.
In Turkey, Sar, Ayas, and Horzum (2015) developed and validated a SAS on a sample of 462 students (mean age = 16 years) who were divided into two groups: 234 high school students and 328 ninth graders. An exploratory factor analysis of the data of the first group produced four factors that explained 63.06% of the total variance: relieving oneself, physical impairment and negligence of daily activities, obstruction of face-to-face communication, and unrestrainable use. Confirmatory factor analysis supported the four-factor structure. The scale also yielded high discriminative validity. Furthermore, results revealed significant sex differences, but only on the first factor (relieving oneself) with girls showing more SA than did boys.

Using the component model approach, Fidan (2016) developed a SAS. The scale was developed around seven factors identified from relevant literature. These were salience, tolerance, withdrawal, mood modification, conflict, relapse, and mobile Internet tendency. The final version of the scale that had 28 items was administered to 284 respondents. Exploratory factor analysis revealed that scale items loaded on the six factors and explained 67.68% of the total variance. Alpha coefficients ranged between .583 and .812, which indicated high reliability. A confirmatory factor analysis supported the six-factor structure of the scale, as all items loaded on a single general factor. The structural equation was as follows: mobile addiction = 2.637 + 0.625 * tolerance + 0.444 * relapse + 0.295 * salience + 0.44 * withdrawal + 0.475 * mobile Internet tendency.

Using a confirmatory factor analysis, Pavia, Cavani, Blasi, and Giordano (2016) established the factor structure of the SPAI. The inventory was applied to 485 students (age range = 19 to 27 years). Exploratory and confirmatory factor analyses revealed that items loaded on five factors: time spent, compulsivity, daily life interference, craving, and sleep interference. This provided a strong indication for the validity of the five-factor structure of the inventory.

Rozgonjuk, Rosenvald, Janno, and Taht (2016) developed a short form of the Estonian SA Proneness Scale (E-SAPS18). The sample consisted of 767 respondents (597 women and 170 men). An exploratory factor analysis revealed that items loaded on five factors: tolerance, positive anticipation, cyberspace-oriented relationships, withdrawal, and physical symptoms. The five alpha coefficients ranged from .68 to .82. The five-factor structure was also supported by a confirmatory factor analysis: $\chi 2 = 131$, df = 73, $p < .001$. RMSEA = .032 (95% CI: .023–.041), CFI = .99, and SRMR = .016. Correlation coefficients among factors and the total score were significant. Significant effects per sex, age, education, and self-evaluation of SA were found.

Ezoe, Iida, Inoue, and Toda (2016) developed a Japanese version of the Smartphone Dependence Scale (J-SDS) with 149 university students. Exploratory factor analysis showed that items loaded on five factors: craving and withdrawal, overuse and tolerance, virtual life orientation, disturbance of concentration in class, and physical symptoms. Alpha reliability coefficients ranged from .69 to .87. The reliability of the total scale was .92.

In sum, survey of the literature on the factor structure of SA reveals inconsistencies regarding the number of factors included in SASs. It is noticeable that factors ranged from three to seven, all loading on a single general factor. Studies found three factors (e.g., Choliz, 2012), four factors (e.g., Lin et al., 2014; Kim et al., 2014; Sar et al., 2015), five factors (e.g., Abo-Jedi, 2008; Ezoe et al., 2016; Rozgonjuk et al., 2016); Pavia et al., 2016), six factors (Fidan, 2016; Fernandez, 2015; Kwon, Lee, et al., 2013), and seven factors (Kwon, Kim, et al., 2013).

2. The SAS

An SAS was developed based on the previously developed scales discussed above (Aljomaa et al., 2016). It consisted of 80 items distributed under five dimensions: time and overuse (11 items), a technological dimension (13 items), a psychological/social dimension (25 items), preoccupation (17 items), and a health/physical dimension (14 items). Questions were answered using a 5-point Likert scale ranging from 5 "*always true of me*" to 1 "*never true of me*." The scale was piloted on 60 students and yielded test-retest and Cronbach's alpha reliability coefficients of .97 and .95, respectively.

However, the psychometric characteristics of the scale (validity and reliability) require examination. Therefore, we reviewed the scale items by presenting it to a larger multidisciplinary jury, examined its factor structure, analysed items according to the modern theory of testing, and quantified traits in scale items. More specifically, using an extended sample, we aimed to:

(a) extract new indices of validity by presenting the scale to referees, conduct a confirmatory factor analysis, match items with the Partial Credit Model, and compute its internal consistency.
(b) extract the reliability coefficients of the scale and its dimensions according to the Latent Variable and Cronbach's alpha methods; and
(c) compute the psychometric characteristics of the scale items.

3. Method

3.1 Participants

Originally, 2022 male and female students were recruited to respond to the SAS; however, 36 students were excluded for incorrect completion of the scale. Consequently, the sample comprised 1986 students (54% men, mean age = 21.58 ± 2.73 years, age range = 18–28 years). Participants came from humanitarian and scientific colleges at four Saudi universities (see Table 1). Application of the scale was implemented in March and April 2016 after securing official consent from participants. Participants who volunteered to complete the scale were informed of the aims of the research. They were also told that the data they provided would remain confidential and would be used only for scientific research purposes. Application took place in the classroom without the presence of the course instructor. The students knew they could withdraw at any time.

Table 1. Participants' age, gender, and affiliation

		M (SD)	n (%)
Age		21.58 (2.73)	
Sex	Male		1072 (54%)
	Female		914 (46%)
College	Foundation Year		477 (24%)
	Scientific		604 (31%)
	Humanitarian		905 (45%)

M: mean, SD: standard deviation

The SAS that was developed by Aljomaa et al. (2016) was used. It consisted of 80 items. After discussion with specialists in counseling psychology, psychological measurement, psychopathology, and computer science, it was shortened to 64 items. Demographic variables such as sex, college, and age were added. The final scale consisted of five dimensions: time and overuse (9 items), a psychological/social dimension (18 items), a health/physical dimension (12 items), preoccupation (13 items), and a technological dimension (12 items). Answers were provided using a 5-point Likert scale ranging from 5 "*always true of me*" to 1 "*never true of me*." A respondent's score on the scale ranged from 64 to 320.

3.2 The SPAI

This inventory was based on a Chinese Internet Addiction Scale (CIAS; Chen, Weng, Su, Wu, & Yang, 2003). It includes five dimensions: compulsivity, tolerance, problems in relations with others, time management, and health, represented by 24 items. The reliability of the inventory was established (Cronbach's alpha α= 0.90) by administering it to 283

Chinese university students, CFA for the five-factor model produced an acceptable fit to the data ($\chi 2$=118.834; $p < 0.000$; CFI= 0.94; TLI =0.97; RMSEA = 0.05. The psychometric characteristics and factor structure of the inventory were also examined in Italy on a sample of 485 university students (Pavia et al., 2016). In the present study, the English version of the inventory was translated into Arabic by two multilingual researchers. The accuracy of the translation was established by the reverse translation of the Arabic version into English by another researcher. The original English version was compared against the back-translated version; although differences were slight, modifications were made to the translated version.

3.3 Statistical Analyses

Descriptive statistics (frequencies, means, and standard deviations) were used to describe the sample regarding demographic variables including the SPAI scores. The normal distribution of items was examined by the Kolmogorov-Smirnov Test. The factor structure of the scale was examined by a confirmatory factor analysis. Because the distribution of some items was not normal, the "weighted least squares mean and variance adjusted" estimation method was used to identify the parameters (Muthen & Muthen, 2013). This method is recommended in cases of ordinal rank data and dichotomous data (Flora & Curran, 2004). Missing data were treated using full information maximum likelihood estimation, which computes values of the parameters by using available data with the assumption of data missing at random. The following indices were used as fit indices: chi-square (χ^2), CFI, Tucker-Lewis Index (TLI), and RMSEA.

The following cut-off scores of the indices TLI and CFI were used to judge model fit: values higher than .95 indicated good fit indices (Schermelleh-Engel, Moosbrugger, & Mueller, 2003) and values between .90 and .95 indicated acceptable fit indices (Kline, 2005; Schermelleh-Engel et al., 2003). Concerning the RMSEA index, values lower than .05 indicated good fit indices, whereas values between .05 and .08 indicated acceptable fit indices. The values 2.5 and -2.5 were used as the maximum and the least limits of fit residual, respectively. Pearson's Correlation Coefficient was used to determine concurrent validity. Further, Cronbach's alpha coefficient and a confirmatory factor analysis were used to determine reliability. All statistical analyses were performed using these programs: IBM SPSS 22, Mplus, and RUMM2020.

4. Results

4.1 Validity Indices

The scale was presented to fourteen specialists, four in counseling psychology, three in measurement and evaluation, three in computer science, two in psychopathology, and two in psychiatry. Based on their comments, some items were re-worded, and 14 items were deleted

for redundancy. This procedure left the scale with 64 items distributed under five dimensions: time and overuse (9 items), the psychological/social dimension (18 items), the health and physical dimension (12 items), preoccupation (13 items) and finally the technological dimension (12 items).

4.2 Confirmatory Factor Analysis

A factor analysis using the five-factor model was performed using maximum likelihood procedure, and fit indices of the model were computed (Table 2).

Table 2. Model fit indices for the confirmatory factor analysis

Index	Value	P-value
χ^2	14983.238	< .001
CFI		.906
TLI		.900
RMSEA		< .001

It is clear from Table 2 that fit indices were for χ^2 and RMSEA index. and acceptable for the CFI and TLI.

4.3 Internal Consistency

Pearson's correlation coefficients were computed for all five dimensions: .713 for time and overuse (9 items), .927 for psychological/social (18 items), .889 for health/physical (12 items), .913 for preoccupation (13 items), and .808 for technological (12 items). All values were significant at the $p < .001$ level, indicating strong correlations. Correlation coefficients among items and their dimensions ranged from .287 to .727 (Table 3).

Table 3. Correlation coefficients among items and their dimensions

Dim. / Item	Time & Overuse	Psychological/Social	Physical	Preoccupation	Technological
1	.574				
2	.591				
3	.561				
4	.553				
5	.687				
6	.649				
7	.699				
8	.505				
9	.643				
10		.578			
11		.521			
12		.441			
13		.639			
14		.666			
15		.562			
16		.568			
17		.716			
18		.625			
19		.636			
20		.696			
21		.713			
22		.616			
23		.631			
24		.688			
25		.687			
26		.647			
27		.631			
28			.620		
29			.502		
30			.441		
31			.373		
32			.650		
33			.929		
34			.651		
35			.287		
36			.623		
37			.671		
38			.696		
39			.637		
40				.653	
41				.615.	
42				.606	
43				.667	

44				.652	
45				.726	
46				.617	
47				.731	
48				.696	
49				.654	
50				.721	
51				.717	
52				.537	
53					.503
54					.544
55					.543
56					.661
57					.673
58					.701
59					.667
60					.574
61					.594
62					.586
63					.679
64					.496

Dim: dimension

The item-total correlation for the items were calculated, ranged from .196 for item 3 and. 659 for item 49.

4.4 *Concurrent Validity*

The present study's SAS was applied concurrently with the SPAI that was validated with Taiwanese and Italian university students. The 24-item SPAI was translated into Arabic and the Arabic version was then back-translated into English to verify the accuracy of translation. The final Arabic version of the SPAI was provided to 73 students in the sample of the study participants. The correlation coefficient between the study's scale and the translated SPAI was .61.

4.5 Reliability Indices

The total scale yielded an alpha coefficient of .96 and alpha coefficients for scale dimensions ranged from .78 to .92 (see Table 4). Scale reliability was also established by the latent variable method via factor analysis. This method yielded a reliability of .98 for the total scale. Reliability values for the dimensions ranged from .83 to .96 (see Table 4).

Table 4. Alpha and latent variable method reliability coefficients of the scale and its dimensions

Subscale	Alpha	Latent variable
Time & overuse	.78	.83 (.80-.86)
Psychological/social	.92	.96 (.94-.98)
Health/physical	.81	.86 (.83-.89)
Preoccupation	.89	.93 (.91-.95)
Technological	.84	.90 (..87-.93)
Total	.96	.98 (.97-.99)

The reliability coefficients resulting from the two methods were high, even though the latent variable method provided higher reliability coefficients for the total scale and its dimensions. The average variance extracted was calculated (AVE=0.288), then the composite reliability was calculated (CR=0.962); this was very close to the alpha coefficient value.

4.6 The Psychometric Characteristics of the Scale Items

The psychometric characteristics of the items were analysed based on the classical theory of measurement via SPSS and the modern theory of testing via RUMM2020. Means, standard deviations, and difficulty parameters of each item were computed. In addition, fit to the rating scale was computed. Table 5 below shows the characteristics of each item.

Table 5. The psychometric characteristics of each item

	Item	Mean *	SD	Difficulty Logit	Standard Error	Fit residual statistics
1	I intend to use my smartphone for some time and I find out that I have spent much more time	3.87	1.224	-0.312	0.021	0.51
2	I never tell others the amount of time I spend with my smartphone	2.70	1.405	0.298	0.019	3.83
3	I feel the time I spend with my smartphone has increased lately	2.32	1.382	0.26	0.018	10.898
4	I tried to reduce the time I spend with my smartphone; however, I failed	2.89	1.382	0.115	0.019	11.34
5	My productivity decreased because of the long time I spend with my smartphone	2.93	1.434	0.097	0.019	-0.967
6	I sometimes use my smartphone to the neglect of more important affairs	2.84	1.390	0.158	0.019	1.637
7	I use my smartphone to update my posts on WhatsApp, Facebook, or Instagram several times a day	2.87	1.413	0.102	0.019	-1.282

8	I feel it is impossible for me to dispense with my smartphone during the day or at night	2.07	1.319	0.329	0.019	8.818
9	I use my smartphone at all times	2.40	1.335	0.397	0.02	0.636
10	I ask my friends to call me to make sure my smartphone works properly	3.61	1.399	-0.292	0.019	2.91
11	I repeatedly get into trouble because of my smartphone ringing in classes, meetings, mosques, etc.	3.63	1.425	-0.303	0.019	2.741
12	I always use applications like WhatsApp, Facebook, and Twitter to make groups and search for friends	2.43	1.309	0.274	0.02	1.691
13	I get so absorbed with my smartphone that I become unaware of people around me	3.13	1.402	-0.053	0.019	-1.853
14	With or without reason, I continually check my e-mail on my smartphone	3.23	1.446	-0.129	0.019	-2.431
15	I feel anxious in places where there is no coverage, or the use of smartphones is prohibited	3.48	1.415	-0.188	0.019	0.948
16	I am keen on adding more friends on my smartphone applications	2.50	1.356	0.309	0.019	1.244
17	I am keen on periodically changing my smartphone to keep abreast with innovations	3.27	1.461	-0.167	0.019	-5.476
18	I get excited and rejoiced when I use some smartphone applications	2.83	1.344	0.174	0.02	-2.419
19	I think that without the smartphone, life would be boring	3.10	1.440	-0.124	0.019	-0.938
20	I get annoyed if someone interrupts me while I am working on some smartphone applications	3.12	1.516	-0.119	0.018	-2.873
21	I get upset and irritable when my smartphone does not work due to Internet connection problems	3.09	1.498	-0.108	0.018	-5.598
22	I feel that social media applications on my smartphone help me to dispense with face-to-face interactions	3.01	1.342	0.069	0.02	-5.669
23	I believe a smartphone is now the best present you offer to a friend or a relative	3.49	1.382	-0.386	0.02	-2.693
24	I feel anxious that my smartphone may suddenly run out of battery	2.72	1.491	0.204	0.018	-3.399
25	I can say that the smartphone is as important to me as water and air are	2.76	1.506	0.123	0.018	-2.848

26	My social relations became limited because of the smartphone	3.32	1.458	-0.151	0.019	-2.846
27	I despise whoever does not have a smartphone	3.33	1.433	-0.186	0.019	-3.006
28	I have some sleep trouble because of my smartphone overuse	2.56	1.510	0.312	0.018	0.168
29	I feel pain in my ears because of my prolonged smartphone usage	2.82	1.330	0.058	0.02	3.358
30	I feel pain in my eyes because of my prolonged smartphone usage	3.92	1.275	-0.412	0.02	5.383
31	I mistakenly feel the smartphone vibrate in my pocket even though I have not received a message	4.04	1.198	-0.408	0.021	5.901
32	I overuse my smartphone even though I realize its health and physical adverse effects	3.32	1.403	-0.3	0.019	-4.666
33	I think my academic level decreased because of my smartphone overuse	3.12	1.470	0.01	0.018	0.981
34	I feel my hand and fingers tremble when I stop using my smartphone	2.87	1.481	0.154	0.018	1.735
35	I feel pain in my wrist because of prolonged smartphone usage	2.68	1.471	0.056	0.018	16.841
36	I feel pain in my body and exhaustion because of prolonged smartphone usage	3.58	1.493	-0.286	0.019	0.62
37	I feel dizzy and suffer from headache because of prolonged smartphone usage	2.66	1.469	0.176	0.018	-3.451
38	Overdependence on the smartphone made me lazier than before	3.22	1.527	-0.108	0.018	-5.938
39	I realize that my smartphone carries many germs and microbes that can cause many diseases	2.53	1.376	0.242	0.019	-2.358
40	I arrive late to my appointments because of indulgence with my smartphone	3.28	1.496	-0.196	0.018	-0.297
41	I get into trouble because of being indulged with my smartphone while doing other things	2.88	1.438	0.164	0.019	0.274
42	I continually check my smartphone to make sure it is not off	3.38	1.454	-0.221	0.019	1.107
43	I use my smartphone when taking public transport or in public places	3.59	1.443	-0.358	0.019	-2.367
44	My over-indulgence with the smartphone exposes me to injuries (critical situations)	3.12	1.358	-0.07	0.02	-2.644
45	I use my smartphone even in the	3.50	1.440	-0.356	0.019	-5.864

	bathroom					
46	I keep my smartphone beside me when I am asleep	2.79	1.399	0.197	0.019	-3.44
47	I use my smartphone in class regardless of instructions from the instructor or the university	2.81	1.476	0.104	0.019	-6.303
48	When asleep, I dream I am using my smartphone applications	2.87	1.462	0.101	0.019	-5.587
49	I keep my eyes and hands on my smartphone while eating or watching TV	3.16	1.498	-0.101	0.018	0.349
50	I get so absorbed with the smartphone that I cannot hear a family member calling me	2.68	1.652	0.056	0.017	-1.639
51	I use my smartphone and its applications while driving	3.01	1.470	-0.185	0.019	-4.881
52	I search for a Wi-Fi point every place I go	3.28	1.448	-0.155	0.019	5.327
53	I use my smartphone to download movies, music, and games	3.68	1.387	-0.354	0.02	0.866
54	My smartphone helps me get along without personal computers	3.61	1.409	-0.313	0.019	-1.038
55	I regularly use more than five applications on my smartphone	2.00	1.361	0.279	0.018	4.979
56	I download photos and videos to send them to others via my smartphone	3.01	1.425	-0.015	0.019	-6.356
57	I depend on my smartphone to listen to supplications and recite Quran	2.33	1.381	0.324	0.019	0.471
58	I want to have more than one smartphone	2.59	1.326	0.214	0.02	-3.245
59	When I am at the university, I use its Wi-Fi	2.94	1.398	0.151	0.019	-2.782
60	I wish to change my smartphone every year to enjoy the recent technological advances	1.99	1.335	0.324	0.019	2.74
61	I want to download smartphone applications daily	2.15	1.377	0.314	0.018	5.606
62	I depend on my smartphone applications as the most valuable resource for my study	2.25	1.379	0.22	0.019	6.875
63	I download study courses and watch them on my smartphone	3.01	1.351	-0.021	0.02	-3.397
64	I totally depend on my smartphone applications to get to places and addresses	2.94	1.525	0.013	0.018	8.171

*The highest possible score is 5, mean: mean, SD: standard deviation.

The floor and ceiling phenomenon did not appear in any of the scale's five dimensions, as the percentage of the data with the least value did not exceed 2% in any of the five dimensions. The same applies to the highest value.

5. Discussion

Although smartphones have many advantages, their overuse causes several problems to their users such as addiction, which requires earnest efforts to alleviate. It is therefore critical to develop good measures of SA. Because measures of SA in Arab countries are limited, this study was conducted to validate the SAS in the Arabic culture. This was the first study, to the best of the researchers' knowledge, to examine the factor structure of the SAS by using a confirmatory factor analysis. Another contribution of this study is the establishment of the scale's reliability by more than one method, as well as its concurrent validity by comparing it to the SPAI, which was validated in Taiwan and Italy (Pavia et al., 2016). Results revealed that the factor analysis fit indices provided acceptable values.

The factor of "time" existed in many previous studies that tackled SA (e.g., Abo-Jedi, 2008, 2013; Choliz, 2012; Kwon et al., 2013; Pavia et al., 2016). This factor may be the most significant factor to contribute to SA. The second dimension, the psychological/social dimension, emerges partially in several phenomena that is reflected in withdrawal (e.g., Chang et al., 2014; Ezoe et al., 2016; Fidan, 2016; Kwon, Lee, et al., 2013; Rozgonjuk et al., 2016), which undoubtedly belongs to the psychological/social dimension. The health/physical dimension appeared in several studies (Demirci et al., 2016, 2014; Ezoe et al., 2016; Kwon et al., 2013; Rozgonjuk et al., 2016; Sar et al., 2015). The preoccupation factor also appeared in more than one study (Ezoe et al., 2016; Fidan, 2016; Rozgonjuk et al., 2016), which is consistent with the concept and indices of SA according to the DSM-5 (2013). Lastly, the technological factor is a basic component in several scales of SA (Kwon, Kim, et al., 2013; Kwon, Lee, et al., 2013; Rozgonjuk et al., 2016).

Regarding internal consistency as an indicator of reliability, the results revealed high correlation coefficients among items and their dimensions, except two items. This raised the fit indices of the five-factor model in the confirmatory factor analysis; therefore, the TLI, CFI, and RMSEA were acceptable. As for concurrent validity, the results revealed a strong indication of similarity with the SPAI. A further explanation for this high concurrent validity is the similar age group (20–35 years) used for the validation of both scales, which has been shown to be the most likely to be addicted to smartphones (Zhitomirsky-Geffet & Blau, 2016).

The results revealed high reliability coefficients using both Cronbach's alpha and latent variable methods. The latent variable method is more reliable, as Cronbach's alpha entails the difficult assumption that all items have the same amount of trait (Jöreskog, 1971).

Concerning psychometric characteristics, scale items had moderate difficulty coefficients, indicating that items can discriminate among levels of addiction in respondents. The fit residual statistics yielded indices that 30 items were not fit. This can be due to variance in participants' responses considering the large sample size.

It is worth mentioning that this scale, though distinguished from other scales regarding dimensions, number of items, and applicability to the target age group, should be used with caution in case it is administered to respondents from older or younger age groups. In addition, environmental and cultural factors should be considered when using this scale. Two other considerations that require attention are the use of chi-square as an index of validity with the large sample size and the substantial number of items that were not fit to the partial rating scale.

6. Implications and limitations

The study was conducted on university students between 18 and 28 years of age. This limits the generalisability of results to other age groups, taking into account that studies conducted on SA among university students in Arabian countries are few. The use of self-report measures in assessing SA may have affected results. Such measures are known to be affected by social desirability that makes participants respond to items in a way that give a positive picture of themselves. The scale is recommended for use with other similar samples in other Middle Eastern countries. Future research should further evaluate the scale to promote its psychometric efficiency.

In the light of the results, we recommend that similar studies be conducted with other age groups in diverse countries, especially considering varied factors like sex, academic major, and academic achievement, which should be examined in addition to psychometric characteristics.

Ethics Statement
The study and protocol were reviewed and approved by the King Saud University's Institutional Committee for the Ethics of Scientific Research.

Conflict of Interest Statement
The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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REFERENCES

Abo-Jedi, A. (2008). Smartphone addiction and its relation to self-revelation in a sample of students from the Jordanian and Amman Private universities. *The Jordanian Journal of Educational Sciences*, *4*(2), 137–150.

Akin, A., Altundag, Y., Turan, M., & Akin, U. (2014). The validity and reliability of the Turkish version of the smart phone addiction scale-short form for adolescents. *Procedia–Social and Behavioral Sciences, 152*, 74–77.

Aljomaa, S., Al-Qudah, M., Albursan, I., Bakhiet, S. & Abduljabbar, A. (2016). Smartphone addiction among university students in the light of some variables. *Computers in Human Behavior, 61*, 155–164. doi: 10.1016/j.chb.2016.03.041

Chen, S. H., Weng, L. J., Su, Y. J., Wu, H. M., & Yang, P. F. (2003). Development of Chinese internet addiction scale and its psychometric study. *Chinese Journal of Psychology*.

Choliz, M. (2012). Mobile phone addiction in adolescence: The Test of Mobile Phone Dependence (TMD). *Progress in Health Sciences*, *2*(1), 33–44.

Demirci, K., Orhan, H., Demirdas, A., Akpinar, A., & Sert, H. (2014). Validity and reliability of the Turkish version of the smartphone addiction scale in a younger population. *Bulletin of Clinical Psychopharmacology*, *24*(3), 226–234. doi: 10.5455/bcp.20140710040824

Diagnostic and Statistical Manual for Mental Disorders–5th Version (2013). Retrieved from http://www.psychatry.org/practice/dsm/dsm5.

Ezoe, S., Iida, T., Inoue, K. and Toda, M. (2016). Development of Japanese Version of Smartphone Dependence Scale. *Open Journal of Preventive Medicine*, *6,* 179–185. doi: 10.4236/ojpm.2016.67017.

Fernandez, O (2015). Short version of the Smartphone Addiction Scale adapted to Spanish and French: Towards a cross-cultural research in problematic mobile phone use, *Addictive Behaviors*, *64*, 1–6. doi: 10.1016/j.addbeh.2015.11.013

Fidan, H. (2016). Development and validation of the Mobile Addiction Scale: The components model approach. *Addicta: The Turkish Journal on Addictions*, *3*, 452–469. doi: 10.15805/addicta.2016.3.0118

Flora, D. B., & Curran, P. J. (2004). An empirical evaluation of alternative methods of estimation for confirmatory factor analysis with ordinal data. *Psychological Methods, 9*, 466. doi: 10.1037/1082-989X.9.4.466

Jöreskog, K. (1971). Simultaneous factor analysis in several populations. Psychometrika, 36(4), 409–426. doi: 10.1007/BF02291366

Kline, R. B. (2005). *Principals and practice of structural equation modeling*. New York: Guilford Press.

Kwon, M, Kim, D. J., Cho, H., & Yang, S. (2013). The Smartphone Addiction Scale: Development and validation of a short version for adolescents. *PLoS ONE*, *8*(12), 1–8. doi: 10.1371/journal.pone.0056936

Kwon, M., Lee, J. Y., Won, W. Y., Park, J. W., Min, J. A., Hahn, C., … Kim, D. J. (2013). Development and validation of a Smartphone Addiction Scale (SAS). *PLoS ONE*, *8*(2), 1–8. doi: 10.1371/journal.pone.0083558

Lin, Y. H., Chang, L. R., Lee, Y. H, Tseng, H. W., Kuo, T. B. J., & Chen, S. H. (2014). Development and validation of the Smartphone Addiction Inventory (SPAI). *PLoS ONE*, *9*(6), 1–5. doi: 10.1371/journal.pone.0098312.

Muthen, L. K., & Muthen, B. O. (2013*). Mplus user's guide* (6th Ed.). Los Angeles, CA: Author.

Pavia, L., Cavani, P., Blasi, M. & Giordano, C. (2016). Smartphone Addiction Inventory (SPAI): Psychometric properties and confirmatory factor analysis. *Computers in Human Behavior*, *63*, 170–178. doi: 10.1016 /j.chb.2016.05.039

Rozgonjuk, D., Rosenvald, V., Janno, S., & Taht, K. (2016). Developing a shorter version of the Estonian Smartphone Addiction Proneness Scale (E-SAPS18). *Cyberpsychology: Journal of Psychosocial Research on Cyberspace, 10*(4), 1–19. doi: 10.5817/CP2016-4-4

Sar, A., Ayas, T., Horzum, M. (2015). Developing the Smart Phone Addiction Scale and its validity and reliability study. *Online Journal of Technology Addiction & Cyberbullying*, *2*(1), 1–17.

Schermelleh-Engel, K., Moosbrugger, H., & Mueller, H. (2003). Evaluating the fit of structural equation models: test of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research–Online, 8*(2), 23–74.

Zhitomirsky-Geffet, M., & Blau, M. (2016). Cross-generational analysis of predictive factors of addictive behavior in smartphone usage. *Computers in Human Behavior, 64,* 682–693. doi: 10.1016/j.chb.2016.07.061