The Malay version of smartphone addiction scale: Development, factor structure and validation of a short form for Malaysian adolescents

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ABSTRACT

Introduction: This study aimed to validate the Malay version of the short form Smartphone Addiction Scale (SAS-M-SF) and to examine its psychometric properties in a cohort of pre-university adolescents.

Methods: We obtained the validity and reliability evidence for the SAS-M-SF using a group of 307 pre-university students in Universiti Putra Malaysia (UPM), Serdang, Selangor, Malaysia with a mean age of 18.4±0.2 years (70.4% female and 29.6% male). A questionnaire containing the Malay version of Smartphone Addiction Scale (SAS-M), the Malay version of the short form Smartphone Addiction Scale (SAS-M-SF), and the Malay version of the Internet Addiction Test (IAT-M) was administered on the adolescents.

Results: The SAS-M-SF displayed good internal consistency (Cronbach's α=0.80). Using principle component analysis, we identified a 4-factor SAS-M-SF model. A significant correlation between the SAS-M-SF and the IAT-M was found, lending support for concurrent validity. The prevalence of smartphone addiction was 54.5% based on cut-off score of ≥36 with a sensitivity of 70.2% and a specificity of 72.5%.

Conclusions: The 10-item SAS-M-SF is a valid and reliable screening tool for smartphone addiction among adolescents. The scale can help clinicians or educators design appropriate intervention and prevention programs targeting smartphone addiction in adolescents at clinical or school settings.

KEYWORDS:
smartphone; internet; addiction; adolescents; Malaysia

INTRODUCTION

The use of smartphone has brought benefits to everyday lives of individuals. Owning a smartphone does not only accelerate social connectivity through social networking sites but also facilitates acquisition of information for learning and entertainment.[1] However, there is growing concern about the overuse of smartphones. Adverse effects associated with overuse of smartphones on psychological, physiological, social, and personal safety domains have been documented.[2] In terms of psychological domain, problematic use of smartphones was associated with emotional disabilities such as depression, anxiety, and stress.[3] The problematic overuse of smartphones can develop into a vicious cycle of great emotional disability.[4] In terms of physiological domain, 38.1% of the heavy users smartphones had reported sleep deprivation.[5] Among heavy users of smartphones, neck and upper trapezius pain due to prolonged stooped posture or prolonged smartphone usage were reported.[2] Pathological smartphone users are prone to developing pain in the flexor pollicis longus tendon and decreased overall hand strength due to prolonged flexion of the wrist.[6] In terms of social domain, excessive use of smartphones was found to cause parental neglect.[7] Overuse of smartphones was also associated with anxiety related to social interaction and compulsive behaviour.[8] In terms of personal safety, distractions from smartphones such as listening to music, phone conversations or text messaging could impair safety of pedestrians and reduce driver performance, leading to motor vehicle accidents.9 All these factors taken together, the predisposition to smartphone overuse for a prolonged duration was shown to predict the development of smartphone addiction.[8]

In the last few years, smartphone ownership has gradually increased worldwide from 45.0% in 2013 to 54.0% in 2015.[8] Adolescents represent a large smartphone owners.[10] Adolescents aged between 10 to 19 years old could be susceptible to develop smartphone addiction, as they do not have the self-regulatory skills needed to resist the sensation and novelty of smartphones.[11] The term addiction is defined as a cluster of physiological, behavioural, and cognitive

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phenomena.[12] There are two major types of addiction: substance addiction (e.g., drugs or alcohol addiction) and behavioural addiction (e.g., mobile phone addiction).[13] The collective time of using smartphones per day is extremely high among adolescents.[11] Latest studies have reported that the prevalence of smartphone addiction ranged from 18.0% to 46.9% among adolescents.[3,7,11] As indicated by a study by Kwon et al.'s in 2013, high prevalence of smartphone addiction among adolescents was reported worldwide.[14]

To date, there are many short forms of smartphone addiction questionnaires that have been developed to measure this addiction for use in adolescents[14] and young adults.[15] The short form of the Smartphone Addiction Scale[14] has been translated into Italian,[15] Chinese,[16] Spanish,[17] French.[17] Few studies have validated the SAS using subjects from Malaysia.[18] In particular, Ching et al., in 2015 validated the Malay version of the SAS (SAS-M) in a group of medical students. As far as psychometric properties are concerned, the SAS-M was found to be as good as the original version.[19] No studies have been conducted to date to validate the shortened form of the SAS-M. The presence of a short form of the SAS-M is practical and saves time for both respondents and administrators. The establishment of SAS-M was limited only for use in adult population. Thus, the present study was aimed to validate the short form of the Malay version of the Smartphone Addiction scale (SAS-M-SF) and to examine its psychometric properties in a cohort of adolescents.

MATERIALS AND METHODS

Study Design, Setting, and sample

This cross-sectional study was conducted in Universiti Putra Malaysia among participants who were pre-university students who fulfilled the inclusion and exclusion criteria. The inclusion criteria were as follows: participants aged 18 years and they must own a smartphone.

Procedure

The current study involved two stages. In Stage 1, we shortened the SAS-M by Ching et al., by conducting content and face validity, and followed this by Stage 2 with exploratory factor analysis (EFA).[18]

Content validity index of SAS-M

We followed to the COSMIN guidelines[20] and Polit and Beck's recommendations[21] in order to shorten the full form SAS-M consisting of 33 items. To examine the content validity of SAS-M-SF, we formed an expert panel consisting of specialists namely two from family medicine, three internal medicine, one psychiatry, one psychologist, and one medical scientist. The panel individually reviewed the items and rated each item with reference to conceptual framework of smartphone addiction based on a Likert scale ranging from 1 (an irrelevant items) to 4 (an extremely relevant item) for each item.[21] Scores of 1 and 2 were regrouped as 0 and scores of 3 and 4 were regrouped as 1. Content validity index (CVI) was calculated by summing up these regrouped values (either 0 and 1) for each item, and then the total value was divided by the total number of experts. We retained items with the CVI value of >0.8 for the SAS-M-SF.[22]

Face validation

All selected SAS-M-SF items were tested on a group of 20 participants who fulfilled the inclusion and exclusion criteria. Each item has a response anchor using a Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree). Possible scores range from 10 to 60. The scale was self-administered. Time spent by participants to complete the scale was recorded. In examining face validity of the SAS-M-SF, participants' feedback on understanding the instructions, contents, and general structure of the items were not limited to the terms used in the scale. Their feedback was then reviewed by the expert panel. Expert panel made all necessary corrections and modifications based on the feedback of the participants. This was to ensure all SAS-M-SF items were comprehensible and ready to be used for subsequent psychometric evaluation.

Sample size determination

We calculated the sample size based on the principle of sample to subject-to-item ratio of 20:1 giving a 200 minimum required sample size.[23,24] The total number of participants needed was 286 after considering a non-response rate of 30%.

Measurements

The SAS-M

The 33-item SAS-M is a screening tool designed to assess the severity of addictive use of smartphone.[18] The scale has five domains encompassing Cyberspace-Oriented Relationships, Daily Life Disturbance, Positive Anticipation, Overuse, and Withdrawal.[18] The Cyberspace-Oriented Relationship domain assesses one's having perceptions about the relationships they have with friends obtained through a smartphone are more intimate than the relationships they have with their real-life friends. The Withdrawal domain assesses one's impatient, fretful, and intolerable behaviours when smartphone is not available. The Daily-Life Disturbance domain assesses one's having hard time concentrating in class or while working. The Positive Anticipation domain assesses one's feeling of emptiness in the absence of smartphone. The Overuse domain assesses one's uncontrollable use of smartphone. Each item has a response anchor using a Likert scale ranging from 1 (strongly disagree) to 6 (strongly agree). Possible scores range from 33 to 198.4 The SAS-M performs optimally at a cut-off value of 99 or above. It has demonstrated good reliability in past research (Cronbach's α=0.94).[18]

The Malay version of the Internet Addiction Test (IAT-M)

Concurrent validity was carried using IAT-M. The 20-item IAT-M is a brief self-report measure of internet addiction. Like the SAS-M, the IAT-M also encompasses five domains: lack of control, neglect of duty, problematic use, social relationship disruption and email primacy. Each item has a response anchor using a Likert scale ranging from 1 (never) to 5 (always). Possible scores range from 20 to 100. The IAT-M performs optimally at a cut-off value of 43 or above. It has demonstrated good reliability in past research (Cronbach's α=0.91).[25]

Data analysis

We used Statistical Package for the Social Sciences version 21.0 (SPSS, Chicago, IL, USA) for the analysis in this study.

Table I: Characteristics of the respondents (n=307)

Characteristics	Mean (SD)	N (%)
Age, years	18.4 (0.2)	
Range (minimum-maximum)	(18.0-18.9)	
Gender		
Male		91 (29.6)
Female		216 (70.4)
Owning smartphone		
Yes		303 (98.7)
No		1 (0.3)
Missing		3 (1.0)
Ethnicity		
Malay		285 (92.8)
Chinese		9 (2.9)
Indians		7 (2.3)
Others		6 (2)
Means hours of smartphone use per week, hours	71.86 (49.8)	
Range (minimum-maximum)	(2-360)	
≤50		130 (42.3)
51-100		79 (25.7)
101-150		72 (23.5)
151-200		14 (4.6)
≥201		1(0.3)
Missing		11 (3.6)
Average house income		
<RM1000		18 (5.9)
RM1000-RM-1999		39 (12.7)
RM2000-RM2999		25 (8.1)
RM3000-RM3999		20 (6.5)
≥RM4000		137 (44.6)
Average age started to use smartphone, years	16.47 (2.05)	
Range (minimum-maximum)	(10-25)	
Average age started to use smartphone regularly, years	15.82 (3.91)	
Range (minimum-maximum)	(0-24)	
Average parents age, years	49.62 (6.2)	
Range (minimum-maximum)	(45-66)	

Table II: Data quality was assessed using mean, SD, median, item response, and missing values, floor and ceiling effects for the Smartphone Addiction Scale-Malay-Short Form

Scale	N	Mean (SD)	Median (IQR)	Statistic for Skewness (p-value)	Statistic for Kurtosis (p-value)	Missing, n (%)	Floor score = 10 (%)	Ceiling score= 60 (%)
10 items SAS-M-SV	307	37.52 (8.63)	37.0 (11.0)	-0.041(0.141)	-0.001 (0.281)	8 (2.6)	0.3	0.7

Table III: Communalities proportion of each variable's variance that can be explained by the factors

Items		Initial	Extraction
B1.	Missing planned work due to smartphone use	0.488	0.729
B2.	Having a hard time concentrating in class, while doing assignments, or while working due to smartphone use	0.493	0.630
B7.	Feeling pleasant or excited while using a smartphone	0.542	0.699
B8.	Feeling confident while using a smartphone	0.592	0.768
B16.	Having my smartphone in my mind even when I am not using it	0.568	0.633
B17.	I will never give up using my smartphone even when my daily life is already greatly affected by it	0.484	0.516
B22.	Not being able to use my smartphone would be as painful as losing a friend	0.623	0.720
B23.	Feeling that my smartphone buddies understand me better than my real-life friends	.609	.711
B28.	My fully charged battery does not last for one whole day	0.227	0.352
B29.	Using my smartphone longer than I had intended	0.375	0.580

Extraction Method: Principal Axis Factoring.

Table IV: Exploratory factor analysis of Smartphone Addiction Scale-Malay-Short Form

Items	Factor			
	Cyber-space orientated relationship/ Withdrawal	Daily Life disturbance	Positive anticipation	Overuse
B5_16 Having my smartphone in my mind even when I am not using it	0.62			
B6_17 I will never give up using my smartphone even when my daily life is already greatly affected by it	0.57			
B7_22 Not being able to use my smartphone would be as painful as losing a friend	0.85			
B8_23 Feeling that my smartphone buddies understand me better than my real-life friends	0.73			
B1_1 Missing planned work due to smartphone use		0.93		
B2_2 Having a hard time concentrating in class, while doing assignments, or while working due to smartphone use		0.54		
B3_7 Feeling pleasant or excited while using a smartphone			0.84	
B4_8 Feeling confident while using a smartphone			0.75	
B9_28 My fully charged battery does not last for one whole day				0.79
B10_29 Using my smartphone longer than I had intended				0.63
Cronbach alpha	0.80	0.70	0.74	0.62
Eigenvalue Variance (%)	37.13	14.10	11.60	10.68

Extraction Method: Principal Axis Factoring.
Rotation Method: Promax with Kaiser Normalization.

Table V: Corrected Item – Total correlations and Cronbach's α if Item deleted for the Smartphone Addiction Scale-Malay-Short Form

Items	Scale Mean if Item Deleted	Scale Variance if Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
B1	33.44	62.69	0.40	0.79
B2	33.81	60.23	0.55	0.78
B3	32.88	65.80	0.41	0.79
B4	33.17	65.54	0.38	0.79
B5	34.23	58.19	0.64	0.76
B6	34.02	58.00	0.64	0.77
B7	34.41	58.01	0.57	0.77
B8	34.93	62.31	0.41	0.79
B9	33.56	62.25	0.34	0.80
B10	33.24	62.96	0.46	0.79

We used content validity index to shorten the full form SAS-M which consists of 33 items.

Data quality was assessed in terms of mean with standard deviation, skewness and kurtosis indices, median, and percentage of missing data. An absolute value of statistic for skewness and kurtosis score which less than -1.96 or greater than 1.96 is significant at $p<0.05$, which implies it is not normally distributed.[26] Floor and ceiling effects were detected if more than 15% of participants achieved the lowest score of the SAS-M-SF (10/60) or the highest score of the SAS-M-SF (60/60).[27] The Cronbach's alpha was used to measure the internal consistency of SAS-M-SF[28] and the normality of the data was assessed through Kolmogorov-Smirnov analysis.[29] Homogeneity of scale items was addressed through correlation coefficients between items and total scores if an item was deleted.[30] Principal axis factoring was used to explore the factor structure of SAS-M-SF.[31] An oblique rotation method was used because we expected the factors to be correlated.[32] All the items were loaded of at least 0.4 and a difference of at least.[25] in absolute value from all other observed factor loading.[32] Pearson's r correlation was used to examine the concurrent validity between the SAS-M-SF with the IAT-M.[25] The optimal SAS-M-SF cut off score for at risk cases was 98 with a maximum sensitivity and specificity based on the Receiver Operating Characteristic (ROC) analyses.[33] We also determined the area under the curve (AUC) of the ROC analyses.

Ethical Clearance
We obtained ethical clearance from the Ethics Committee for Research involving Human Subjects (FPSK-EXP16-P157) of UPM to conduct the study. We also obtained written consent from participants prior to the data collection.

RESULTS

Item selection for the short form SAS-M-SF
Regarding content validity index for the SAS-M-SF, 10-items were chosen by the experts as CVI was found to be 1 for items 1, 2, 16, and 22 and >0.8 for items 7, 8, 17, 23, 28, and 29. Therefore, these 10 items were retained. All 10 participants found the SAS-M-SF was clear and easy to understand. However, they commented that the instructions to complete the scale could be simplified to achieve greater clarity. No other actions were needed to change the meaning of the SAS-M-SF items. Participants spent 10 minutes, on average, to answer the SAS-M-SF.

Sample characteristics
Sociodemographic characteristics of the present sample are shown in Table I. The mean age of the study population was 18.4 (0.2) years with a range between 18.0 and 18.9 years. The present sample was predominantly females (70.4%) and Malays (92.8%). The mean of smartphone use per week was 72 (50) hours with a range between two and 360 hours. Participants started to use smartphones regularly at age of 16 (4) years.

Data quality of the SAS-M-SF and their floor-and-ceiling effects
The number of adolescents who answered each item was 307 people with a missing value of 2.6%. The mean was 37.5 (SD=8.63) and median was 37.0 (IQR=11). Skewness and kurtosis values were all within acceptable range (statistic's p-value >0.05). No floor and ceiling effects were detected as only 0.3 % of participants achieved the lowest score of the SAS-M-SF (10/60) and only 0.7% achieved the highest score of the SAS-M-SF (60/60) (Table II).

Factor Structure and Internal Consistency
During exploratory factor analysis, the Kaiser-Mayer-Olkin measure of sampling adequacy for the SAS-M-SF was 0.815 indicating middling. In addition, the Bartlett's test of sphericity was significant (p<0.01) which indicated that factor analysis was appropriate. Using principal axis factoring (eigenvalue >1.000), we identified a 4-factor SAS-M-SF model. These factors together accounted for 73.5% of total variance. This result was slightly higher than the SAS-M whereby 65.3% of total variance was reported compared with current study.[18] The communalities were shown in Table III. The communalities in the column labelled Extraction reflect the common variance in the data structure. The percentage of the variance explained by communalities after extraction ranged between 35.2 and 76.8%. Among in communalities, item 8 explained 76.8% of variance, followed by item 1 (72.9%), item 22 (72.0%), and item 23 (71.1%).

Internal consistency reliability of the SAS-M-SF
Cronbach's alpha coefficients were 0.80 for the total scale, 0.80 for Cyber-Space Orientated relationship/Withdrawal subscale, 0.70 for Daily Life Disturbance subscale, 0.74 for Positive Anticipation subscale, and 0.62 for Overuse subscale (Table IV). These findings infer that the SAS-M-SF has good internal consistency. In Table V, the reliability analysis showed that deletion of any of the items would not increase the internal consistency of the total score.

Concurrent validity of the SAS-M-SF with the other scales
The intra-class correlation (ICC) between the SAS-M-SF and the SAS-M was 0.941 with p value <0.001, indicating that they have good parallel form reliability. The concurrent validity of the SAS-M-SF was measured using Pearson's *r* correlation analysis. Analysis found that Most the subscales of SAS-M-SF were significantly related to the IAT-M.

Diagnostic ability of the SAS-M-SF by gender
The area under the receiver operating characteristic curve (AUC) was 0.78 (95% Confidence Interval, 95%CI: 0.72, 0.84). As indicated by the SAS-M-SF, its optimal cut-off score to identify smartphone addiction was ≥36. Based on this score, the prevalence of smartphone addiction in the present sample was 55.4% with a sensitivity of 70.2% and a specificity of 72.5%. In subgroup exploratory analysis by gender, the AUC was 0.80 (95%CI: 0 .69, 0.91) for male and 0.77 (95%CI: 0.70, 0.84) for female. The optimal cut-off score to identify smartphone addiction was ≥36 for male with a sensitivity of 74.1% and a specificity of 73.9%. For the male sample, the positive predictive value was 53.1%, whereas the negative predictive value was 88.2%. The optimal cut-off score to identify smartphone addiction was ≥35 for female with a sensitivity of 73.1% and a specificity of 61.4%. For the female sample, the positive predictive value was 50.0%, whereas the negative predictive value was 81.2%.

DISCUSSION

We simplified the original SAS-M items in the hope of developing an age appropriate SAS-M scale for use in adolescents. To this end, the SAS-M-SF was evaluated in a group of pre-university adolescents. The data quality was high with few missing values. No floor or ceiling effects on the SAS-M-SF were detected. This study is an extension of Ching et al.,[18] by examining the psychometric properties of the SAS-M-SF for assessing smartphone addiction in Malaysian adolescents. The SAS-M-SF is validated in a Malaysian sample. Hence, its psychometric properties are population specific. No cross-validation studies examining the factor structure of the SAS-M-SF in other countries are currently available.

The SAS-M[18] and SAS-M-SF had a significant moderate positive correlation, indicating preliminary evidence for parallel form reliability. To reduce the burden on participants, short-form measures like the SAS-M-SF are proving useful and practical. Using principle component analysis, we identified a 4-factor SAS-M-SF model. The first factor, known as Cyberspace-Oriented Relationship/Withdrawal, has two components. The first component inquiries regarding individuals' perceptions about the way they formed online relationship is more comfortable than offline relationship. As for the second component, individuals exhibit intolerable behaviours when

there is no smartphone. The second factor, known as Daily-Life Disturbance, concerns individuals' missing planned work and poor concentration in class or while working. They also experienced dizziness or obscured vision, torment on the wrists or at the back of the neck, and sleeping disturbance. The third factor, known as Positive Anticipation, is portrayed as individuals' feeling amped up for and disposing of worry with smartphone use and feeling void without a smartphone. The fourth factor, known as Overuse, signifies individuals' uncontrollable use of their smartphone such as continually setting up charging pack.

Like other existing short forms of the SAS,[19] the SAS-M-SF was found to be significantly and positively correlated with internet addiction. Preliminary evidence for convergent validity of the SAS-M-SF was established in the present study. Optimal cut-off scores to identify smartphone addiction were ≥36 for the total sample. The prevalence of smartphone addiction was 55.4% in the current study. It is somewhat unsurprising that because the high smartphone usage in Malaysia whereby 53.4% of Malaysians own a smartphone.[34] Extensive literature shows that there was a gender difference in smartphone usage pattern. Females were at higher risk for smartphone addiction and had greater tendency to consciously reveal their problems with smartphone use than their male counterparts.[35] However, no gender differences were found during the stage of smartphone addiction. In the present study, based on the SAS-M-SF cut-off score of ≥36, about 89 male participants showed a positive predictive value of 53.1% and a negative predictive value of 88.2%. On the other hand, based on the SAS-M-SF cut-off score of ≥35, about 210 female participants reported a positive predictive value of 50.0% and a negative predictive value of 81.2%. In both the male and female subjects, the percentage obtained for negative predictive values was higher than those obtained for positive predictive values, suggesting a "true negative" prediction. One practical implication is that the SAS-M-SF could be used to identify and prevent early smartphone addiction in adolescents. This result is similar with Kwon's study.[36,37]

Smartphone addictions have become a public health issue. Adolescents were found to have low levels of refusal and self-control ability to withdraw themselves from the involvement in smartphone activities.[38] Hence, efforts to validate a shortened form of the SAS-M is important for two reasons. Firstly, the prevalence of smartphone addiction among adolescents is yet to be formally reported and therefore a reliable and valid tool for such cyber-addictive behaviour in this age group is greatly needed. The SAS-M was established in a sample of adults, thus our current attempt to investigate the psychometric properties of the SAS-M-SF in a group of adolescents was crucial to address the need for an age-appropriate scale. Secondly, a tool for identifying adolescents who are at-risk for smartphone addiction can help clinicians and educators design appropriate intervention and prevention programs at clinical or school settings.

Strengths and Limitations

To the best of our knowledge, this is the first study to demonstrate that the SAS-M-SF can be also used as a valid and reliable screening tool to assess smartphone addiction among adolescents in Malaysia. Despite its brevity, the SAS-M-SF was found to exhibit good psychometric profile. The SAS-M-SF has exhibited good data quality as reflected by the low percentage of missing value and the absence of floor and ceiling effects. Our study identified a 4-factor model for the SAS-M-SF and these factors together accounted for 73.5% of total variance. This result was slightly higher than the SAS-M whereby 65.3% of total variance was reported compared with current study.[18] However, the limitations of the study was that all the participants were recruited from a single centre in Malaysia, thus limiting generalisability of the present findings. Furthermore, issues surrounding the unequal distribution of gender and ethnicity in the present cohort should be highlighted. In the present study, we only presented findings from EFA and confirmatory factor analysis (CFA) was not performed. We acknowledge this as a study limitation. However, it appears that separate cohort should be used for EFA and CFA of the SAS-M-SF to counteract the issue of overfitting.[31] Taken together, this suggests that future work is still needed for the SAS-M-SF and performing a CFA on separate data would be necessary at minimum. The utility of the SAS-M-SF should be carefully interpreted within the context of its limitations. In addition, the SAS-M-SF is a screening tool in predicting risk of addiction, therefore assessment results deriving from the SAS-M-SF must be interpreted with caution. The SAS-M-SF is not fashioned as a diagnostic tool. Thus, the SAS-M-SF is a valid and reliable screening tool. Our recommendation is that adolescents at-risk for smartphone addiction (i.e., SAS-M-SF scores ≥36) could be referred to psychiatric specialists for further assessment.

CONCLUSION

The 10-item SAS-M-SF is a valid and reliable tool. The scale can help clinicians and educators design appropriate intervention and prevention programs targeting smartphone addiction in adolescents at clinical or school settings.

DECLARATIONS

FUNDING STATEMENT

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CONFLICTS OF INTEREST

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.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

The study procedures were carried out in accordance with the Declaration of Helsinki. The ethical committee of UPM (FPSK-EXP16-P157) granted permission to conduct the study. Written consent was obtained from participants prior to the data collection.

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