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Original Article

Smartphone Addiction Among Zimbabwean Undergraduate Students: A Prevalence and Cross-Cultural Validation of the Smartphone Addiction Scale-Short Version (SAS-SV)

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Abstract

Introduction: Smartphones are an invaluable daily tool, with 57% of the global population (4.6 billion people) having mobile access to the internet. However, excessive/problematic use of smartphones is highly prevalent globally. The use of smartphones, particularly among university students, offers many unique opportunities for learning, entrepreneurship, and social interaction. Despite these benefits, "excessive" or "compulsive" use of smartphones has emerged as a growing concern.

Methods: This cross-sectional study evaluated the validity and reliability of the Smartphone Addiction Scale-Short Version (SAS-SV). We also assessed the prevalence of smartphone addiction and its factors among Zimbabwean university students (N = 380). Data were analysed through factor analyses and binary logistic regression using SPSS and STATA at a 0.05 significance level.

Findings: Participants' mean age was 21.90 (±1.90) years, and most participants were female (56.3%). The SAS-SV yielded a two-factor solution, with high reliability (α = 0.84) and sufficient construct validity. The prevalence of smartphone addiction was 54.2%. Using social media [OR = 2.7; 95% CI = (1.2–5.9)], using a smartphone for entertainment [OR = 2.2; 95%CI = (1.2–4.0)], experiencing coronavirus-induced anxiety [OR = 2.70; 95% CI = (1.2-5.9)], and encountering an adverse event [OR = 1.8; 95% CI = (1.02 – 3.23)] were associated with an increased risk of smartphone addiction. Conversely, using smartphones for academic work was protective against smartphone addiction [OR = 0.38; 95% CI = (0.19–0.77)].

Conclusion: Our study shows the SAS-SV is a brief and psychometrically robust outcome measure for routine clinical and research usage. Also, there is a high burden of smartphone addiction among university students from low-income countries and the need for bespoke interventions.

Keywords: Addiction, Risk factors, Psychometrics, Anxiety, Depression

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Introduction

Smartphones are an invaluable tool in daily life, with 57% of the global population (4.6 billion people) having mobile access to the internet.[1] Globally, there has been a concurrent upsurge in smartphone use among university students.[2] The use of smartphones among university students offers many opportunities for learning, entrepreneurship, and social interaction. Despite these benefits, "excessive" or "compulsive" use of smartphones is a growing concern.[3] Due to their portability and convenient internet access, smartphones pose a potential risk for immoderate and addictive behaviours, with multilevel impacts.[4,5] Smartphone addiction, or problematic mobile phone use, is characterised by an inability to regulate one's usage of a gadget, the presence of withdrawal symptoms after a period of non-use, and impacts on daily life.[6] It is a behavioural addiction similar to internet gambling, shopping, or video game addiction and leads to severe impairment or distress.[4] A meta-analysis of 82 studies involving 147,319 participants reported a global smartphone addiction prevalence of 27.0% in the general population.[7] Notably, the highest prevalence of smartphone addiction was reported in lower-middle-income countries (LMICs), with a pooled prevalence of 43.8%.[7] These findings highlight the increasing global burden of smartphone addiction, with LMICs disproportionately affected. Likewise, systematic reviews reveal a high prevalence of smartphone addiction among university students, with rates varying from 36.5% to 65%.[8] This variability partially reflects the absence of definitive diagnostic criteria and diverse risk factors.[8,9] Behavioural traits such as physical inactivity, lower self-esteem, and poor communication skills are known salient

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risk factors for developing smartphone addiction among university students.[3,10] For instance, a cross-sectional study of Chinese college students (N = 650) revealed that physical activity and self-esteem were negatively correlated with smartphone addiction, with self-esteem partially mediating this relationship.[11] Furthermore, psychosocial stressors and relational problems, including high levels of social and academic stress, further increase the risk for smartphone addiction. For example, cross-sectional studies conducted in Sudan (N = 231) and Uganda (N = 269) reported smartphone addiction prevalence rates of 67.6% and 45.72%, respectively, with significant correlates to depression, anxiety, and poor academic performance.[12,13] Additionally, sociodemographic predictors such as gender, age, study level, city residence, single-parent or restructured family status, being single, and experiencing financial difficulties have been identified as strong contributors to smartphone addiction.[5]

The consequences of problematic smartphone use among university students are multifaceted and mutually reinforcing. For example, stress, anxiety, procrastination, poor academic outcomes, reduced sleep, and physical activity.[10,14] A systematic review of 34 studies from Korea found that 11 reported negative impacts of smartphone addiction on students with anxiety and depression.[15] One cross-sectional study of 608 students found a significant association between smartphone addiction and psychotic anxiety symptoms such as stress, depression, and suicidal ideation [OR = 1.98; 95% CI = 1.22–3.21].[16] These findings highlight the cyclical relationship between psychological distress and excessive smartphone use.[16] Moreover, pandemics have further exacerbated the surging prevalence of smartphone addiction.[17] A cross-sectional study of 2,005 students at San Diego University reported a significant increase in smartphone use during the COVID-19 pandemic, with 51.7% spending more than four hours daily compared to 34.9% before the pandemic.[18]

Despite smartphone addiction being an emerging global epidemic, its measurement is fragmented. For instance, more than 30 tools have been identified in four systematic reviews (4) conducted exploring the effects of smartphones on university students; no review has focused explicitly on measurement properties, including validity and reliability indices.[3,8,15,19] Nevertheless, the Smartphone Addiction Scale (SAS), Smartphone Addiction Proneness Scale (SAPS), and Mobile Phone Problematic Use Scale (MPPUS) are widely used outcome measures for assessing smartphone addiction.[20] Thus, this study primarily evaluated the validity and reliability of the Smartphone Addiction Scale–Short Version (SAS-SV) as applied to tertiary students in Zimbabwe. Furthermore, although smartphone addiction may impact the mental and physical health of tertiary students, there is limited information available from low-income contexts, and existing studies report inconsistent prevalence rates. Therefore, the secondary objective of this study was to determine the prevalence of smartphone addiction and its associated factors among Zimbabwean university students. The paucity of information on smartphone addiction in low-resource settings is partly attributable to the lack of epidemiological studies using culturally adapted smartphone addiction outcome measures to give bespoke data on smartphone addiction burden and predictors. Study outcomes may inform the development and measurement of bespoke interventions harnessing the utility of digital platforms in university students from low-income countries and addressing the epidemic of smartphone addiction.

Methods

Participants and procedure

Participants were full-time undergraduates enrolled at the University of Zimbabwe (UZ). A cross-sectional study was conducted from May to July 2021 at the height of the COVID-19 pandemic. All 17,718 registered undergraduates, constituting the universe/target population were eligible for recruitment into the study were eligible to participate. Of these, a sample of 380 students was recruited, based on the sample size calculation parameters outlined subsequently. Recruitment involved approaching prospective participants in person, explaining the study, and securing informed consent. Our eligibility criteria were as follows:

- Inclusion: Registered undergraduate student, aged 18 ≥ years or older
- Exclusion: Unable to provide written informed consent or under the influence of substances at the time of the survey.

Sampling

The sample size was calculated based on the study's primary aim, which is the evaluation of the factorial structure of the 10-item Smartphone Addiction Scale-short version (SAS-SV). Literature recommends a participant-to-item ratio of 5-20 participants per item on the scale.[21] We sought to recruit at least 300 participants to ensure a minimum of 15 participants per item for both exploratory and confirmatory factor analysis. A total of 380 participants were consecutively recruited into the study. Oversampling was performed to account for extreme scores during analysis.

Measurements

Sociodemographic Questionnaire

A sociodemographic questionnaire was used to collect information, such as gender, age, program, level of study, drinking and smoking history, food adequacy, and financial adequacy.

Smartphone Addiction Scale-short version (SAS-SV)

Smartphone addiction was assessed using the SAS-SV. The SAS-SV is a standardized 10-item smartphone addiction outcome measure.[22] The English version was used as is in the study without any modifications. Each item is rated on a 6-point scale, ranging from 1 (strongly disagree) to 6 (strongly agree). The cumulative score range is 10 to 60; scores ≥ 33 suggest smartphone addiction.[22,23] It is a brief and easy-to-administer screening tool that has cross-

cultural validity. In a Nigerian study, the SAV-SV yielded a Cronbach α = 0.8, evidence of reliability.[24]

Patient Health Questionnaire-4 (PHQ-4)

The PHQ-4 was used to assess the levels of anxiety and depression. Each item is scored based on a 4-point scale, from 0 (not at all) to 3 (nearly every day), giving a total score range of 0-12. Scores are rated as: normal (0-2), mild (3-5), moderate (6-8), and severe (9-12). The PHQ-4 is a short, easy-to-administer screening tool with robust psychometric performance.[25]

Coronavirus-related Anxiety Scale (CAS)

Coronavirus-related anxiety was assessed using the CAS. The CAS is a validated self-report of COVID-19-associated dysfunctional anxiety. It has five questions rated on a 5-point Likert scale ranging from not at all = 0 to nearly every day = 4. The score range is 0-12, with scores ≥ 9 suggesting probable dysfunctional coronavirus-related anxiety. The CAS is a reliable tool (Cronbach α = 0.9) with robust diagnostic performance.[26]

EuroQOL 5 Dimensions, 5 Levels (EQ-5D-5L)

HRQoL was measured using the EQ-5D-5L. The EQ-5D 5L is a generic and psychometrically robust HRQoL measure.[27] Health is assessed in five dimensions, i.e., mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Problem severity is rated on a 5-point Likert Scale ranging from 1 = not at all to 5 = all the time. The EQ-5D 5L also includes a visual analogue scale, ranging from 0 (worst health imaginable) to 100 (best health imaginable).[27]

Statistical analysis

Descriptive statistics summarized participant characteristics (e.g., means and standard deviations, mode) and response frequencies (e.g., percentages). Due to the absence of established cut-off points for the Smartphone Addiction Scale -Short version (SAS-SV), the primary outcome, participants were classified based on their mean scores. Participants scoring below the mean of the study sample were categorized as having low smartphone addiction. The SAS-SV scores are interpreted such that higher scores indicate greater levels of smartphone addiction. This approach was utilized to determine the prevalence of smartphone addiction in this study. Next, we conducted bivariate analysis (e.g., Chi-squared and t-tests) to determine factors associated with smartphone addiction. Finally, all variables with p-values of ≤ 0.20 were included in the multivariate binary logistic model to identify significant predictors after adjusting for covariance and confounding factors. These are presented as adjusted odds ratios. Data were randomly split into two for exploratory and confirmatory factor analysis to assess the SAS-SV's structural validity. In short, the performance of both analyses increases the robustness of the structural validation, and the detailed analysis plan is presented in Additional File S1. Further, internal consistency was evaluated using Cronbach's Alpha (criteria: α ≥ 0.7). Pearson's correlation coefficient was applied to assess construct validity by determining the correlation between SAS-SV scores and secondary outcome measures (e.g., depression); criteria: r > 0.4. Known-group validity was assessed using logistic regression. Analyses were performed using SPSS (Version 29) and STATA (Version 16), with a significance level of 0.05.

Results

Descriptive statistics

The participants' mean age was 21.90 ± 1.90 years. Most participants were females (56.3%), in their second year (34.2%), used their phones for communication (85.8%), were in a relationship (50.5%), had somewhat adequate finances (45.8%), had experienced no adverse event in the past month (80.8%), were non-smokers (89.5%), consumed alcohol (62.1%) and did not use substances (92.1%) (Table 1).

Structural validity

The results of the exploratory factor analysis (EFA) method supported a two-factor solution accounting for 54.4% of the variance. The EFA supplementary outputs are outlined in Supplementary File. As shown in Table 2, confirmatory factor analysis (CFA) supported the Japanese bifactor structure, which exhibited the best fit, and the final model

Table 1. Participant characteristics; N = 380

Variable	Attribute	n (%)
Gender	Female	214 (56.3)
	Male	166 (43.7)
Age	Mean	21.90 ± 1.90
Year of study	1	113 (29.7)
	2	130 (34.2)
	3	36 (9.5)
	4	101 (26.6)
Mean smartphone usage in hours/day	Mean	9.50 ± 3.60
Smartphone usage	Academic work	309 (81.3)
	Social media	326 (85.8)
	Communication	317 (83.4)
	Entertainment	282 (74.2)
	Other	13 (3.4)
Alcohol intake	No	144 (37.9)
	Yes	236 (62.1)
Smoking status	No	340 (89.5)
	Yes	40 (10.5)
Drug and substance use	No	350 (92.1)
	Yes	30 (7.9)
Relationship status	In a relationship	192 (50.5)
	Not in a relationship	173 (45.5)
	Other	15 (3,9)
Perceived financial adequacy	Very inadequate	40 (10.5)
	Inadequate	84 (22.1)
	Somewhat adequate	174 (45.8)

is visually depicted in Figure 1.

Scale internal consistency

The SAS-SV yielded high scale-level internal consistency, Cronbach's Alpha = 0.840 [95%: 0.803: 0.872]. Stepwise deletion of items did not reduce alpha to less than 0.81, further evidence of high internal consistency (Supplementary File). The daily life disturbance and overuse factors yielded the following reliability indices: Cronbach's Alpha = 0.831 [95%: 0.803, 0.856] and Cronbach's Alpha = 0.726 [95%: 0.681, 0.767], respectively.

Correlations between study variables

There was a weak negative correlation between smartphone addiction scores and HRQoL (r = -0.187; $P < 0.001$). There was no statistically significant linear relationship between smartphone addiction and anxiety, depression, and COVID-19-related anxiety - See S2 Additional Table 1.

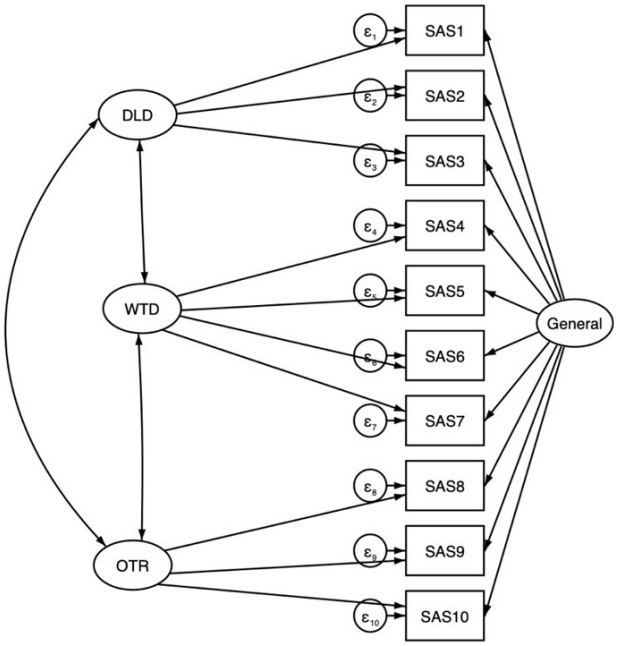

Figure 1. SAS-SV bifactor solution

Logistic regression analysis

After controlling for potential covariates, social media usage [OR = 2.7: 95% CI = (1.2 – 5.9), $P < 0.009$] using a smartphone for entertainment [OR = 2.2: CI (.2 – 4.0), $P < 0.009$], the experience of coronavirus-induced anxiety [OR = 1.1: 95%CI = (1.0 – 3.2), $P < 0.013$], and an adverse event [OR 1.8: 95%CI = (1.0 - 3.2), $P < 0.013$] were associated with increased smartphone addiction. Using smartphones for academic work was protective against smartphone addiction [OR = 0.38: 95%CI = (0.19 - 0.77), $P < 0.007$] (Table 3).

Table 3. Determinants of smartphone addiction

Variable	Attributes	Adjusted OR [95% CI]	*P*-value
Overall smartphone usage (hours)	*	1.001 (1.00; 1.001)	0.021
Social media usage	Yes	**2.748 (1.282; 5.890)**	**0.009**
	No (ref)		
Academic work usage	Yes	**0.383 (0.192; 0.766)**	**0.007**
	No (ref)		
Communication usage	Yes	1.095 (0.516; 2.321)	0.813
	No (ref)		
Entertainment usage	Yes	**2.195 (1.213; 3.970)**	**0.009**
	No (ref)		
PHQ-4 Score	*	1 (0.907; 1.104)	0.992
CAS Score	*	**1.161 (1.032; 1.306)**	**0.013**
Adverse event	Yes	**1.814 (1.020; 3.227)**	**0.043**
	No (ref)		
Drinking Status	Yes	0.995 (0.633; 1.565)	0.984
	No (ref)		
Constant		0.203	<.001

* Data are in numeric form, not categories
Values presented in bold indicate statistically significant associations, defined as $P < 0.05$

Table 2. SAS-SV Confirmatory Factor Analysis Solutions

	Likelihood Ratio		Population error	Information criteria		Baseline comparison		Size of residuals	
Index	**Chi-Square**	**Modified Chi(χ^2/df)**	**RMSEA (95% CI)**	**AIC**	**BIC**	**CFI**	**TLI**	**SRMR**	**CD**
Criteria	***P*>.005**	**Fit: χ^2/df≤2**	**Fit:≤0.06**	**Fit: Model with lowest AIC**	**Fit: Model with lowest BIC**	**Fit:≥0.90**	**Fit:≥0.90**	**Fit:≤0.06**	**Fit: greatest SD value**
M1: Original one-factor model	Statistic: χ^2 (df=35)=153.8, p<.001Fit: poor fit	Statistic: 4.4 Fit: poor fit	Statistic:.134 (.113,.156) Fit: poor fit	6645.2	6742.6	Statistic: 0.83 Fit: Optimal fit	Statistic: 0.782 Fit: Optimal fit	0.079 Fit: poor fit	0.885
M2: Japanese Model 1	Statistic: χ^2 (df=32)=144.9, p<.001 Fit: poor fit	Statistic: 4.5 Fit: poor fit	Statistic:.137 (.114,.159) Fit: poor fit	6642.1	6749.2	Statistic: 0.839 Fit: Optimal fit	Statistic: 0.774 Fit: Optimal fit	0.082 Fit: poor fit	0.936
M3: Japanese bifactor two-group fit	Statistic: χ^2 (df=22)=56.1 Fit: poor fit	Statistic: 2.6 Fit: Optimal fit	Statistic:.091 (.062,.120) Fit: Optimal fit	6573.5: Best fit	6713.1: Best fit	Statistic: 0.951 Fit: Best fit	Statistic: 0.9 Fit: Best fit	0.053 Fit: Best fit	1: Best fit
M4: EFA solution	Statistic: χ^2 (df=34)=153.2, p<.001 Fit: poor fit	Statistic: 4.5 Fit: poor fit	Statistic:.136 (.115,.159) Fit: poor fit	6646.6	6747.3	Statistic: 0.83 Fit: Optimal fit	Statistic: 0.775 Fit: Optimal fit	0.079 Fit: poor fit	0.874

Discussion

Overall synthesis

The present study aimed to evaluate the validity and reliability of the Smartphone Addiction Scale-Short Version (SAS-SV). We also evaluated the prevalence of smartphone addiction among university students in Zimbabwe and examined its associations with sociodemographic factors, health-related quality of life (HRQoL), anxiety, and depression within this population.

SAS-SV validity and reliability

Our study supports the structural validity of the SAS-SV in Zimbabwean university students. This is noteworthy, as structural validity is an essential psychometric property upon which the rest of the psychometric properties depend.[28] Exploratory factor analysis yielded a two-factor structure, with CFA suggesting a high-order bifactor structure. The SAS-SV is a widely used smartphone addiction outcome measure with a variable factorial structure; this partially reflects the differences in the conceptualisation of the tenets of smartphone addiction across contexts.[29–31] The SAS-SV was derived from the original 33-item Smartphone Addiction Scale (SAS), which has six (6) factors, i.e., daily-life disturbance, positive anticipation, withdrawal, cyberspace-oriented relationship, overuse, and tolerance domains/factors.[22] However, the SAS-SV was derived by a panel of experts using content validation indices without a formal structural validity evaluation.[22] The variability in the factorial structure of the SAS-SV, as observed in follow-up studies,[29–31] can be attributed in part to the absence of a defined a priori factorial structure. This uncertainty regarding the structural validity of the SAS-SV has contributed to a persistent gap in understanding, a trend that continues to be reflected in subsequent research. For instance, a US study validating the SAS and SAS-SV reports the structural validity of the SAS (long version) and only the predictive and concurrent validity of the SAS-SV without providing the structural validity outputs.[32] Nevertheless, the psychometric performance of the SAS-SV was comparable to that of the longer version, further supporting the potential utility of the SAS-SV for potential routine use, given its brevity.[32] Elsewhere, the Hungarian version of the SAS-SV yielded a unidimensional factor solution using CFA; the questionnaire was validated among university students.[31] A unidimensional factor solution in Brazil yielded poor fit indices using CFA modelling. Consequently, principal component analysis was applied and yielded an improved fit with the Brazilian version, explaining a 39.2% variance.[33] Unfortunately, principal component analysis is not technically a factor analytical method and has been misapplied in validation studies,[34] adding to the opaqueness of the SAS-SV psychometric robustness evidence base. In fact, for classical theory testing analytical methods, CFA is a more robust and preferable structural validity analysis method for translated and cross-culturally updated outcome measures validation.[28] Like the present study, the Serbian SAS-SV yielded a two-factor structure, explaining 62.4% of the variance.[30] A close inspection shows dissimilarities in item loadings between the Serbian and current studies, further evidence of the differences in the conceptualisation of smartphone addiction across contexts. Although the Serbian SAS-SV accounted for great variance, the study also applied principal component analysis with varimax rotation; these methodological shortfalls can potentially impact the study's internal and external validity. Orthogonal rotation is only valid/applicable for multi-attribute outcome measures with sub-scales measuring different constructs.[34] Yet, the SAS-SV is a unidimensional measure that only measures smartphone addiction. Using similar analytical methods as in the present study, the Chinese version of the SAS-SV yielded a three-factor structure, further illustrating the differences in the conceptualisation of smartphone addiction across contexts.[29] A future meta-analysis is required to provide conclusive evidence of the SAS-SV structural validity.

The SAS-SV yielded a high internal consistency ($\alpha = .84$), which is comparable to previous validation studies, i.e., the Hungarian version ($\alpha = .79$),[31] emerging adults in the US ($\alpha = .84$),[32] Brazilian university students ($\alpha = .82$),[33] Serbian university students ($\alpha = .89$),[30] and the Chinese version validated in college students ($\alpha = .88$).[29] Internal consistency is a function of the number of items on a questionnaire[34] [53]. The SAS-SV with only 10 items exceeded the minimum acceptable threshold ($\alpha \geq 0.7$)[28,34], which is additional evidence of its reliability. Notably, except for item number 4 (Won't be able to stand not having a smartphone), the inter-item correlations were high, demonstrating that the SAS-SV measures a similar construct, i.e., smartphone addiction. The overall scale internal consistency improved to ($\alpha \geq 0.86$) upon the removal of item 4. Therefore, there may be a need to reword the item or perform some additional qualitative work to explore the perceived meaning of the item from the target population using cognitive debriefing techniques such as think-aloud techniques or card-ranking exercises.[35] Despite the poor performance of item 4, the SAS-SV displayed adequate reliability to warrant its usage for routine clinical and research purposes. Notably, the SAS-SV had robust evidence of construct validity by correlating well with other theorised constructs. For example, in this study, increased COVID-19-induced anxiety was associated with increased smartphone addiction. The COVID-19 pandemic was associated with increased smartphone usage and information-seeking,[36] which the SAS-SV accurately captured in this study.

Smartphone Addiction – prevalence and associated factors

The prevalence of smartphone addiction in our study population was 54.2%, which is higher than most global estimates of 27%[37–39] and studies from comparable countries. For instance, studies conducted on university students in Nigeria reported an addiction rate of 18.4% ($N = 398$), while a study in Cameroon found a rate of 21% ($N = 634$). Both studies utilized the Smartphone Addiction Scale-Short version (SAS-SV) for their measurements.[38,40]

Methodological differences can partially explain the huge disparities. For instance, the differential use of outcome measures and definitions of smartphone addiction may account for the differences. Our study was conducted at the height of the COVID-19 pandemic, a period characterized by an increase in online learning and the introduction of discounted tertiary student internet data packages[41]; this may have resulted in greater smartphone usage. Elsewhere, a Jordanian undergraduate survey (N = 6157) shows that most of the participants (85%) greatly increased their smartphone usage during the COVID-19-induced lockdowns, with 42% using their smartphones for more than six hours a day.[42] Nevertheless, our results are comparable to the findings from studies on university students in Saudi Arabia (N = 2367)[43] and Egypt (N = 700).[44] The prevalence of smartphone addiction in these countries was 48% and 44.7%, respectively.[43,44]

In our study, the experience of COVID-19-related anxiety was associated with increased smartphone usage. This is unsurprising, as the COVID-19 pandemic was associated with a lot of uncertainty and information-seeking behaviours.[45] In this study, using smartphones for social media (OR = 2.7, $P < 0.009$) and entertainment (OR = 2.2, $P < 0.009$) was associated with increased levels of smartphone addiction. Similarly, research among Turkish (N = 819) and Ethiopian (N = 1232) university students reveals the significant impact of the COVID-19 pandemic on smartphone addiction.[46,47] In both contexts, smartphone usage became a primary tool for communication, education, and coping during the pandemic, leading to increased dependency observed across student populations. The versatility of smartphones, including applications that provide gaming, video watching, social contact, and online messaging, can propel smartphone addiction.[48] In low-resource settings, the usage of social media platforms such as Facebook and WhatsApp is prevalent.[48] For instance, WhatsApp usage accounts for over 20% of time spent on smartphones daily, with some university students spending more than three hours daily on WhatsApp.[48,49] A cross-sectional survey of Iranian university students (N = 383) also showed that smartphone addiction was high among internet service and social networking users.[50] The increased social media usage in low-resource settings is also attributable to increased digital penetration.

In this study, students who experienced an adverse event [OR = 1.8, $P < 0.013$] were more likely to develop smartphone addiction. These findings follow a meta-analysis in a sample of 2780 nursing students showing a strong association between high social distress and smartphone addiction (r = 0.163, $P < 0.028$) .[10] In the wake of an adverse event, increased smartphone usage can be a positive coping mechanism because of the need to communicate with close family and friends for social support.[51] Conversely, increased smartphone usage can also be a maladaptive coping strategy. Increasing smartphone usage can temporarily divert one's attention from an adverse event through increased usage of social media and other smartphone utilities. Unfortunately, the increased usage may evolve into problematic smartphone usage beyond resolving the adverse event.[52] On the contrary, using a smartphone for academic work was associated with lower smartphone addiction scores [OR = 0.383, $P < 0.007$]. A cross-sectional study exploring the smartphone usage patterns for Pakistani medical students (N = 270) revealed that students who mostly used smartphones to browse the internet to find medical information (100%), share educational material (90%), and take notes (79%) were at a lower risk of addiction. These students were at lower risk of smartphone addiction, suggesting that more productive use of a smartphone may be a protective factor against addiction. Earlier studies also highlight the protective benefits of smartphone use, including the reduction of the digital gap, enhanced peer collaboration, and instant access to information.[53,54] Therefore, we propose that future research prioritise understanding the purpose of smartphone use compared to time spent on a device or frequency of use.

We hypothesised that participants at risk of smartphone addiction were more likely to experience poor mental health. The findings of the present study show that increased smartphone usage was associated with poorer HRQoL. Increased smartphone usage can have physical (e.g., fatigue, poor sleep) and psychological (e.g., withdrawal symptoms) effects, thus negatively affecting HRQoL.[10] Contrary to other studies, our study revealed a null association between smartphone addiction, anxiety, and depression. This was surprising, as the literature shows that students with smartphone addiction are up to five times more likely to develop depression and anxiety [OR 5.0: CI: 3.3 - 7.5].[40] We used the PHQ-4, which was not validated in the research setting and population. The cut-off points gleaned from the literature may not have adequate diagnostic accuracy. Further studies are needed to explore the relationship between anxiety, depression, and smartphone addiction.

Conclusion

Our study findings must be critically appraised, given inherent strengths and weaknesses. Participants were recruited using convenience sampling, which may introduce selection bias. Future studies should recruit participants using random selection. We also recruited participants from a single university; this may limit the study's external validity. However, the University of Zimbabwe is the largest tertiary institution in Zimbabwe, recruiting students nationally, which may increase the study's internal validity. Future studies should consider multisite participant recruitment. The psychometric evaluation of the SAS-SV was conducted retrospectively using factor analysis. However, other critical properties, such as test-retest reliability, were not assessed. Furthermore, we did not identify any studies employing alternative measurement methodologies, such as item response theory approaches, which address the limitations inherent in classical testing theory approaches. Thus, robust validation studies are required to evaluate the SAS-SV psychometric performance

further. Also, the lack of specified cut-off points for the SAS-SV is a potential drawback in the calculation of smartphone addiction prevalence; as such, our estimate needs to be interpreted with caution. Future studies, employing temporary methods such as latent class analysis and diagnostic accuracy studies comparing the SAS-SV specificity and sensitivity with clinician diagnoses as the gold standard, are needed to accurately calculate the burden of smartphone addiction. Overall, our results suggest a high burden of smartphone addiction among university students from low-income countries. Given the multilevel effects of smartphone addiction, there is a need for bespoke interventions. Future studies are needed to disentangle the long-term impact of increased smartphone usage on university students' mental and academic outcomes, including further validation of the SAS-SV in this context.

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Competing Interests
All authors declare no conflict of interest.

Data Availability Statement
The datasets used and/or analysed during this study are available from the corresponding author upon reasonable request. They will be uploaded to online repositories once all manuscripts related to the study have been published.

Ethical Approval
This study was conducted in accordance with the Declaration of Helsinki. It was approved by the Institutional Review Board (Joint Research and Ethics Committee) of the University of Zimbabwe, Faculty of Medicine and Health Sciences, and Parirenyatwa Group of Hospitals (Ref: JREC 238/2021). All methods followed the guidelines and regulations of the Joint Research and Ethics Committee. All participants were treated as autonomous agents and provided written informed consent before participation. None required consent from a legal guardian. To preserve confidentiality, datasets were anonymised, and randomised participant ID numbers were used.

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Supplementary Files
Supplementary File contains Table S1-S3 and Figure.

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