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Connected or Isolated? Examining the Associations between Smartphone Use, Mental Health, and Phubbing: Moderated Mediation via Bayesian Networks with Machine Learning

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Abstract

This study investigated whether smartphone addiction mediates the relationships between symptoms of stress, anxiety, and depression and phubbing behavior in Brazilian university students. A total of 348 students (67% women; M age = 22.7) participated in the study, responding to the Smartphone Addiction Scale–Short Version (SAS-SV), the Phubbing Scale, and the Depression, Anxiety, and Stress Scale (DASS-21). The analyses included Pearson correlations, multiple regression, mediation models with bootstrapping, and Bayesian networks. The results indicated that smartphone addiction was strongly associated with phubbing and moderately related to mental health symptoms. In the multiple regression model, stress (β = .42, p = .001), anxiety (β = .28, p = .004), and depression (β = .19, p = .032) together explained 10.5% of the variance in phubbing (R^2 = .105). The mediation models suggested that smartphone addiction acted as a partial mediator of the relationships between stress/anxiety and phubbing and as a full mediator between depression and phubbing. Bayesian networks confirmed that the probabilistic dependencies were consistent with these findings. Additional analyses revealed variations in effects as a function of sex and race, although estimates in smaller subgroups should be interpreted with caution. The results reinforce smartphone addiction as a plausible mechanism connecting emotional symptoms to problematic social behaviors in digital contexts.

Introduction

Phubbing behavior is defined as the act of ignoring others in social interactions to focus on one's smartphone. This phenomenon was originally composed of the factors of communication disturbance and telephone obsession (Karadag et al., 2015). has evolved to incorporate other dimensions that facilitate its understanding, such as Nomophobia, Interpersonal Conflict, Self-Isolation, Problem Recognition, Perceived Norms, and Feeling Ignored (Chotpitayasunondh & Douglas, 2018).

This behavior has become increasingly prevalent among university students (Basti et al., 2021; Elamin et al., 2024; Zhang et al., 2022), which converges with the growing presence of smartphones in the lives of these individuals, leading to the emergence of problems such as smartphone addiction, characterized by compulsive use resulting in physical, psychological, or social harm (Ting & Chen, 2020).

Phubbing and Smartphone Addiction: Associations with Mental Health and Mediating and Moderating Mechanisms

Phubbing has been frequently associated with symptoms of anxiety, stress, and depression, which are also prevalent in student populations (Elamin et al., 2024; Lai et al., 2022; Zhang et al., 2022, 2023a). Smartphone addiction has been identified as a possible consequence of social anxiety (Lai et al., 2022) and depression (Zhang et al., 2023b), given that anxious individuals may use their smartphones to cope with negative emotions (Elhai et al., 2019). Furthermore, high levels of depression can lead individuals to use smartphones as a maladaptive coping mechanism (Ge et al., 2023). This pattern suggests that

emotional symptoms can favor problematic smartphone use, strengthening its association with phubbing.

Recent studies have focused on exploring the latent mechanisms involved in phubbing behavior, demonstrating that smartphone addiction mediates the relationship between phubbing and factors such as fear of missing out, social comparison (Bajwa et al., 2023), and boredom proneness (Zhao et al., 2021a). These findings align with those of Santos et al. (2023b), who highlighted the connection between digital behavior, emotional regulation, and impulsivity associated with neuroticism, which indicates how psychological vulnerability can lead to maladaptive digital strategies, such as phubbing, especially in stressful contexts such as the university environment. These findings support the hypothesis that smartphone addiction functions as an intermediate mechanism between psychological vulnerabilities and problematic digital behaviors, such as phubbing.

The literature indicates that anxious individuals develop phubbing as a way to reduce the discomfort associated with social interactions by using their smartphones, as they prefer online communication because they fear negative evaluations (Bitar et al., 2023). Phubbing has been associated with compensatory strategies among adolescents who are victims of bullying, which are linked to depressive symptoms (Gao et al., 2024), and it has also been developed by students with higher levels of stress (Zhang et al., 2025). In this sense, the findings of Bitar et al. (2023), Gao et al. (2024), and Zhang et al. (2025) suggest that phubbing behavior is not only a risk factor for the development of problematic mental health outcomes (depression, anxiety, and stress), making it necessary to consider interventional and preventive measures for phubbing in different sociodemographic groups who already report psychological distress associated with mental health symptoms and smartphone addiction in academic settings.

A Bayesian Network Approach and the Relevance of the Amazonian Context

Despite these advances, studies with correlational and predictive analyses prevail. Studies investigating how smartphone addiction mediates the relationship between mental health symptoms and phubbing, as well as the moderating role of sociodemographic variables in this mediation, especially considering phubbing as an outcome rather than a symptom, as is more common in the literature (Ergün et al., 2019), are still rare.

Furthermore, given the youth of the field, studies on phubbing that apply Bayesian networks, a particularly useful tool of probabilistic graphical models that represent conditional independence relationships between variables, are still scarce. In these models, edges indicate possible causal effects, linking a causal symptom to an effect, which is an advantageous approach for overcoming one of the main limitations of partial correlation networks, which have undirected edges, and for allowing the identification of admissible causal relationships in cross-sectional data (Briganti et al., 2023).

Even fewer studies have investigated this relationship in Amazonian contexts, considering race and gender among university students in northern Brazil. In particular, Amazonas is the state with the largest indigenous population in the country (over 490,000 people, 62% in urban areas), with Manaus leading in absolute numbers (IBGE, 2023). Exploring this dynamic under regional particularities can offer relevant insights into the phenomenon in diverse sociocultural contexts, highlighting a gap still little explored in the literature. Considering the scarcity of Latin American studies, especially in the Amazon, this work expands the understanding of how cultural, racial, and gender factors are associated with problematic smartphone use.

Given this, the present study aims to investigate whether smartphone addiction mediates the relationships among stress, depressive symptoms, and anxiety with phubbing behavior and the moderating role of sociodemographic variables in this relationship among Amazonian university students. The main hypotheses are as follows: (1) smartphone addiction mediates the relationship between stress and phubbing; (2) smartphone addiction mediates the relationship between depressive symptoms and phubbing; (3) smartphone addiction mediates the relationship between anxiety and phubbing; and (4) gender moderates the relationship between mental health symptoms and phubbing mediated by smartphone addiction.

The findings of this quantitative research can contribute to a better understanding of how emotional variabilities can lead to maladaptive digital behaviors and how sociodemographic variables can affect this variability. The results support the development of strategies to promote healthier smartphone use and mitigate the negative impact of mental health symptoms on excessive device use and social interactions among university students, considering sociodemographic differences. Furthermore, it also allows for a greater understanding of the role of mental health as an important risk factor for the development of behavioral problems associated with technology, such as phubbing behavior.

Method

Participants and ethical issues

A total of 348 university students aged between 18 and 53 years (M = 22.69, SD = 4.53) participated in this study. Most participants identified as cisgender women (67.24%), followed by cisgender men (28.16%), nonbinary individuals (1.44%), and others (3.16%). In terms of race, 65.7% self-identified as black, 31% as white, and 0.8% as indigenous. In addition, 42.2% were enrolled in humanities courses. The inclusion criterion was to be enrolled in an undergraduate program at a public or private higher education institution (HEI).

This project was submitted for review by the Research Ethics Committee of Amazonas Federal University in accordance with the Declaration of Helsinki. Approved under Opinion No. XXXXXX, and all participants provided informed consent prior to participation. Clinical trial number: not applicable.

Instruments

Sociodemographic Questionnaire

This questionnaire collected demographic information, including age, sex, self-identified race, weekly smartphone use (in hours), type of higher education institution (private or public), field of study, and current academic semester.

Smartphone Addiction Scale

Smartphone dependence was measured via the Brazilian Portuguese version of the Smartphone Addiction Scale–Short Version (SAS-SV; Kwon et al., 2013), adapted by Andrade et al. (2020). The SAS-SV consists of 10 items (e.g., *“I fail to complete planned tasks or work because of my cell phone use”; “I become impatient and irritable when I am without my cell phone and have difficulty concentrating in class, on homework, or at work because of my cell phone use,” etc.*) rated on a 6-point Likert scale (1 = strongly disagree to 6 = strongly agree). Higher scores indicate greater dependence on smartphones. The scale demonstrated good internal consistency. (α = 0,83).

Phubbing Scale

Phubbing behavior was assessed via the Brazilian Portuguese version of 9 items from the Phubbing Scale (PS), which was originally developed by Karadag et al. (2015) and adapted by Santos et al. (2023a). The scale includes two subscales: (1) Communication disturbance (items 1–4) (e.g., my eyes are fixed on my cell phone when I am with other people, and I am always busy with my cell phone when I am with friends) and (2) Cell phone obsession (items 5–9) (e.g., my cell phone is always within reach, and I spend increasingly less time on social, personal, and professional activities due to cell phone use). Responses are given on a 5-point Likert scale (1 = never to 5 = always). The Cronbach's alpha values were 0.83 for Communication Disorder, 0.75 for Cell Phone Obsession, and 0.83 for the total scale.

DASS2-21

Mental health symptoms were measured via the Brazilian Portuguese version of the DASS-21, which was originally developed by Lovibond and Lovibond (1995) and adapted by Vignola (2013). The scale consists of 21 items divided into three subscales: depression (e.g., I felt unenthusiastic about everything and felt worthless as a person), anxiety (e.g., I felt afraid for no reason and was worried about situations in which I might panic and look ridiculous), and stress (e.g., I felt that I was always nervous and had difficulty relaxing). The items are rated on a 4-point Likert scale (0 = Does not apply to me at all to 3 = Applies to me very much or most of the time). The Cronbach's alpha values were 0.92 for depression, 0.86 for anxiety, and 0.90 for stress.

Data collection procedures

Data collection was conducted online via a self-administered questionnaire developed in Google Forms. Participants were recruited through social media platforms (e.g., Facebook, WhatsApp, and Instagram) by sharing the study link. Upon clicking on the link, the participants were directed to an informed consent form. Only after providing consent were they allowed to complete the questionnaire. The average completion time was approximately 5 minutes. Data collection took place between June and August 2022.

Data analysis

All analyses were performed via the latest versions of R (version 4.5.0) and RStudio (2025.05.0), using the *lavaan package* for mediation and moderation modeling with *bootstrapping*, *psych/for data manipulation and description (e.g., descriptive analyses, correlation, regression), bnlearn* for Bayesian network analysis, and *mediation* for formal testing of indirect effects.

Descriptive statistics (means, standard deviations, frequencies, percentages) were calculated for all study variables. Pearson correlation analyses were used to examine the relationships between variables. Cronbach's alpha was used to assess the internal consistency of the scales.

To identify whether stress, anxiety, and depression predict phubbing behavior, multiple linear regression was performed, and to determine whether they predict excessive smartphone use, each symptom was associated with smartphone use via simple linear regression.

To examine the associations between depressive symptoms, anxiety, and stress (independent variables) and phubbing behavior (dependent variable), with smartphone addiction as a mediating variable and sociodemographic characteristics (gender, race, city) as moderating variables, mediation and moderation analyses (Hayes, 2022) and structural equation modeling (SEM) were conducted to assess model fit via the CFI, RMSEA, and SRMR indices.

The normality of the residuals was tested via the Shapiro–Wilk test, with $p > 0.05$ for all the models. Linearity was verified via scatter plots and residual analysis. Homocedasticity, tested by the Breusch–Pagan test, $p > 0.05$, indicating constant variance of the residuals and the absence of multicollinearity, was verified by a VIF of 2 for all the predictors. All the models met the basic assumptions of regression.

The analysis was performed via the nonparametric bootstrapping method proposed by Preacher and Hayes (2008). For each model, the direct, indirect, and total effects were estimated by bootstrapping with 5,000 resamples, and 95% confidence intervals were used to determine the significance of the effects, with p values of 0.05 considered statistically significant.

To expand the mediation and moderation analyses, a Bayesian network analysis was performed. Bayesian networks (BNs) are a class of probabilistic graphical models (PGMs) that represent conditional dependency relationships between random variables in the form of directed acyclic graphs (Fischer, 2021; Barth, 2023). PGMs are a fundamental subarea of machine learning, as they combine graph theory and statistics to model uncertainties and infer probabilities in complex systems. (Silva & Costa, 2023).

PGMs, including Bayesian networks, are widely used in machine learning to structure knowledge about variables and their interrelationships, allowing probabilistic inferences to be made even in the face of incomplete or uncertain data (Barth, 2023). BRs are constructed from nodes, which represent variables, and directed edges, which indicate conditional dependencies between these variables, forming an acyclic graph (UFRJ, 2023). Each node has a conditional probability distribution (CPD) that describes the probability of the variable given the state of its parents in the network. The calculation of these probabilities is based on Bayes' theorem, which updates beliefs about events as new evidence is incorporated (Fischer, 2021). This formulation allows RBs to capture complex relationships of dependency and conditional independence, enabling the modeling of interdependent systems with multiple variables. (Silva & Costa, 2023).

Bayesian networks operate by propagating conditional probabilities throughout the graph, which allows us to infer how changes in one variable influence others, even in complex structures with multiple dependency paths (Fischer, 2021). This feature enables BNs to capture effects analogous to those of mediation through indirect paths between variables and moderation through conditional interactions that modify the strength or direction of relationships (Garcia et al., 2021). In addition, RBs have the ability to perform intercausal inference, known as “explaining away,” where evidence in one hypothesis reduces belief in competing hypotheses, amplifying the explanatory power of the model (Fischer, 2021; Jensen, 1996).

Results

Descriptive and correlation analysis

The descriptive statistics and correlation coefficients for the main variables of the study are presented in Table 1. On average, participants reported using their smartphones for approximately 7 hours per day, including approximately 3 hours per day spent on social media.

Smartphone addiction showed a strong positive correlation with phubbing behavior ($r = 0.75$, $p < .001$), indicating a robust association between problematic smartphone use and ignoring others in social interactions. In addition, smartphone addiction was moderately correlated with depressive symptoms ($r = 0.35$, $p < 0.001$), anxiety ($r = 0.37$, $p < 0.001$), and stress ($r = 0.38$, $p < 0.001$).

Table 1
Means and correlations and internal consistency.

Variables		M ± SD	Pearson correlation					α
			1	2	3	4	5	
1	Smartphone addiction	31.6 ± 10.3	1					0.83
2	Depression	8.4 ± 6.2	0.35***	1				0.90
3	Anxiety	6.5 ± 5.8	0.37***	0.70***	1			0.88
4	Stress	9.5 ± 5.9	0.38***	0.70***	0.81***	1		0.90
5	Phubbing	24.5 ± 5.9	0.75***	0.31***	0.32***	0.33***	1	0.80

Note: M represents the mean total score of the variable; SD is the standard deviation; *** p < 0,001; α corresponds to Cronbach's alpha; "Depression" refers to the depression subscale of the DASS-21; "Anxiety" refers to the anxiety subscale of the DASS-21; and "Stress" refers to the stress subscale of the DASS-21.

The results suggest that greater emotional distress is linked to increased excessive smartphone use and phubbing behavior. All the measurement instruments showed good internal consistency, with Cronbach's alpha coefficients above 0.80.

Multiple linear regression analysis

A statistically significant model in which stress, anxiety, and depression are predictors of phubbing was identified, $F(3, 346) = 13.56$, p .001, ($R^2 = 0.105$), explaining 10.5% of the variance in phubbing, as shown in Table 2. Stress was the most significant predictor ($\beta = 0.42$, $p = .001$, $R^2 = 0.070$), followed by anxiety ($\beta = 0.28$, $p = .004$, $R^2 = 0.022$) and depression ($\beta = 0.19$, $p = .032$, $R^2 = 0.013$).

Table 2
Predictive models of phubbing

Model	Variables included	R^2	ΔR^2	F	p
1	Stress	0,070	–	26,04	< .001
2	+ Anxiety	0,092	0,022	18,39	< .001
3	+ Depression	0,105	0,013	13,56	< .001

The sequential inclusion of variables reveals a gradual increase in explanatory power, with each variable adding a portion to the explained variance, with anxiety and depression adding smaller but significant contributions to the model.

Simple linear regression analysis

Stress, anxiety, and depression were identified as predictors of excessive smartphone use, with stress having the most significant impact on excessive smartphone use (β = 0.50, p .001), with a strong association, followed by anxiety (β = 0.31, p .001), with a moderate association, and depression (β = 0.20, p .001), with a weak association. .001), with a strong association, followed by anxiety (β = 0.31, p = .001), with a moderate association, and depression (β = 0.22, p = .015), with a weak but significant association. The data can be viewed in Table 3.

Table 3
Predictors of smartphone addiction

Variable	β	t	R^2	SE	p
Stress	0,50	7,14	0,128	0,07	< 0,001
Anxiety	0,50	3,88	0,041	0,08	< 0,001
Depression	0,22	2,44	0,017	0,09	0,015

Stress stands out, explaining 12.8% of the variance in smartphone addiction (R^2 = 0.128), whereas anxiety and depression had smaller but still significant contributions.

Mediation Analysis

Mediation analyses provided evidence of the mediating role of smartphone addiction in the relationship between mental health symptoms and phubbing behavior (see Table 4). Specifically, the analysis involving stress symptoms revealed a direct effect on phubbing behavior that remained significant when smartphone addiction was included as a mediator (β = 0.21, p .004), indicating partial mediation with an indirect effect of β = 0.21, p .001. The direct effect of anxiety also remained significant when the mediating variable (β = 0.16, p .018) was included, indicating partial mediation with an indirect effect of (β = 0.14, p .002). The direct effect of depressive symptoms on phubbing became insignificant when the mediating variable was included in the model (β = 0.11, p = .080), but the indirect effect, mediated by smartphone addiction, was statistically significant (β = 0.09, p = .035), confirming complete mediation.

SEM showed good structural model fit indices: CFI = 0.96, RMSEA = 0.045 (90% CI), and SRMR = 0.038. Residual normality was tested via the Shapiro–Wilk test, with p > .05 for all the models. Linearity was verified via scatter plots and residual analysis. Homoscedasticity was tested via the Breusch–Pagan test, p > .05, indicating constant variance of the residuals and the absence of multicollinearity variance inflation factor (VIF) 2 for all the predictors. In all cases, the indirect effects presented moderate to high magnitudes, and the confidence intervals did not include the value zero, indicating robust statistical significance.

Table 4
Direct and indirect effects for each symptom in the mediation model

Variable	Indirect effect (β)	95% IC Bootstrap	p (indirect)	Direct effect (β)	p (direto)
Stress	0,21	[0,12, 0,30]	< 0,001	0,21	0,004
Anxiety	0,14	[0,05, 0,23]	0,002	0,16	0,018
Depression	0,09	[0,01, 0,18]	0,035	0,11	0,080

These findings suggest the presence of partial mediation, in which a substantial part of the effect of stress and anxiety symptoms on phubbing is transmitted through smartphone addiction, and complete mediation, in which the effect of depressive symptoms on phubbing is completely mediated by smartphone addiction. The results clearly and robustly confirm the objective of the research. The results indicate that smartphone addiction mediates the relationships between depressive, anxiety, and stress symptoms and phubbing behavior in college students. In other words, part of the impact of these mental health symptoms on phubbing occurs through smartphone addiction, which acts as an intermediary mechanism.

Moderation Analysis

The moderation analysis identified demographic and contextual variables that significantly moderate the mediation relationships. The results are summarized in Table 5.

Table 5
Significant Moderation (p < .05)

Moderator (M)	Moderate Relationship	M Level	Coef. X → M	p X → M	R^2 X → M	Coef. M → Y	p M → Y	R^2 M → Y
Gender	Anxiety →SA→ Phubbing	1	0,44	0,037	0,16	0,42	0,41	0,16
Gender	Stress →SA→ Phubbing	1	0,45	0,024	0,17	0,43	0,038	0,16
Gender	Depression →SA→ Phubbing	1	0,37	0,045	0,16	0,39	0,042	0,16
Gender	MH→SA→ Phubbing	1	2,72	0,039	0,19	2,50	0,040	0,18
Race	Anxiety →SA→ Phubbing	3	0,78	0,0085	0,51	0,75	0,0091	0,50
Race	Stress → SA→ Phubbing	3	0,74	0,0102	0,50	0,79	0,0078	0,52
Race	Depression → SA→ Phubbing	3	0,79	0,0078	0,52	0,77	0,0088	0,51
Race	MH→ SA→ Phubbing	3	0,76	0,0091	0,51	0,74	0,0099	0,50

Note: SA = Smartphone addiction, MH = Mental health

The results indicate that gender moderates both the relationship between mental health symptoms and smartphone addiction (first stage of mediation), with more intense effects observed in men (p = 0.05, R^2 = 0.19), with the model explaining 19% of the variance in smartphone addiction, and the relationship between smartphone addiction and phubbing (second stage of mediation), with the model explaining 19% of the variance in phubbing, as shown in Table 2. .05, (R^2 = 0.19) with the model explaining 19% of the variance in smartphone addiction, as well as the relationship between smartphone addiction and phubbing (second stage of mediation) p .05, (R^2 = 0.18) explaining 18% of the variance in phubbing.

Race moderates the relationship between mental health symptoms and smartphone addiction (first stage of mediation), with more pronounced effects among self-declared Asian individuals ($p = 0.01$; $R^2 = 0.51$), with the model explaining 51% of the variance in smartphone addiction, as well as the relationship between smartphone addiction and phubbing (second stage of mediation), with the model explaining 51% of the variance in phubbing, as well as the relationship between.01 ($R^2 = 0.51$), with the model explaining 51% of the variance in smartphone addiction, as well as the relationship between smartphone addiction and phubbing (second stage of mediation) $p = .01$ ($R^2 = 0.50$), explaining 50% of the variance in phubbing.

These findings suggest that the indirect effects of mental health symptoms on phubbing behavior, mediated by smartphone addiction, vary significantly depending on specific demographic and contextual characteristics.

Bayesian networks

For network evaluation and validation, in addition to the BIC used in the learning process, k-fold cross-validation ($k = 10$) was performed, which indicated high consistency in the learned structure and predictive robustness of the model. This consistency, expressed in predictive performance measures such as accuracy, sensitivity, and specificity, presented values above 85%, indicating good generalizability and prediction capacity, especially for phubbing behavior.

The Bayesian network generated had a density of 0.30 and an average Markov blanket size of 1.2, indicating a simple, sparse, and easily interpretable structure. The BIC score of -1781.15 points indicates a good balance between fit and parsimony, even in the absence of log-likelihood. The network was validated with a training–test split (80–20%), which strengthens its generalizability. These indicators suggest that the network is suitable for modeling key causal relationships between variables.

The following findings stand out (see Fig. 1): stress influences anxiety, which in turn influences depression; stress also has a direct influence on smartphone addiction, which mediates the effect on phubbing behavior. The estimated conditional probabilities for these relationships indicate strong and statistically robust associations, with high probability values in the upper quartiles of the variables involved.

The validity of causal inference depends on compliance with these assumptions and the absence of unmodeled latent variables, which represents an inherent limitation of the model.

Discussion

This study investigated whether smartphone addiction mediates the relationships among depressive symptoms, anxiety, stress, and phubbing in college students. The results confirmed all four hypotheses. Smartphone addiction significantly mediated the link between emotional distress and phubbing, and gender and race moderated these relationships. Additionally, the race variable significantly moderates these relationships. These findings highlight the importance of understanding how psychological

vulnerabilities can translate into problematic digital behaviors in academic settings and vary significantly depending on specific demographic and contextual characteristics.

Research has empirically validated smartphone addiction as a psychological mechanism that connects mental health to phubbing. Previous studies have linked smartphone addiction, anxiety, stress, depression, and phubbing separately (Bajwa et al., 2022; Lai et al., 2022; Talan et al., 2024). This study, however, tested these relationships via structural equation modeling and Bayesian networks (Hayes, 2018), providing robust support for a theoretical model that integrates these factors.

The results show that emotional distress directly increases phubbing and indirectly via smartphone addiction. Smartphone addiction is a partial mediator of stress and anxiety and a complete mediator of depression. The literature has already satisfactorily explored the relationship between smartphone addiction and phubbing (Karadag et al., 2015; Bajwa et al., 2023; Zhao et al., 2021a). Therefore, we focus on the relationship between mental health and smartphone addiction (the first stage of mediation).

The use of smartphones as a mediator between stress and phubbing

The effect of stress was particularly strong and robust. Bayesian network analysis revealed a direct influence of stress on smartphone addiction, which mediated the effect on phubbing behavior. These findings suggest that problematic smartphone use among college students may be a compensatory response to psychological distress. College students face high levels of stress due to academic pressures and life transitions. This leads to excessive smartphone use as an escapist coping mechanism (Oh & Kim, 2020; Ye et al., 2024).

This pattern, as suggested by Bakır and Dilmaç (2023) and Bitar et al. (2023), reinforces phubbing behavior, reducing face-to-face communication and increasing social isolation (Amin et al., 2024), corroborating the findings of the present study, which identified strong positive relationships between smartphone addiction and phubbing behavior.

Flynn et al. (2020) reported that highly stressed students are more dependent on smartphones and that dependence is associated with avoidant behavior, which is also a characteristic of people who engage in phubbing (Sun & Miller, 2023). A longitudinal study by de Ye et al. (2024) reinforced these findings by revealing that students with high initial stress levels also had a deep addiction to smartphones. Faced with the stressors of university life, they turn to smartphones as a coping tool, where the satisfaction provided by the device further increases their frequency of use, creating a vicious cycle.

Smartphones as a mediator of the relationship between anxiety and phubbing

The relationship between anxiety and smartphone addiction has a solid basis in the literature, with individuals often resorting to smartphones as a coping mechanism to address the emotional discomfort

associated with anxiety (Bitar et al., 2023; Elhai et al., 2019; Lai et al., 2022). These maladaptive strategies reinforce problematic patterns of smartphone use, creating a vicious cycle, and social withdrawal manifests as phubbing behavior (Al-Qudah et al., 2021; Kwak et al., 2022).

Wang et al. (2025) identified social anxiety as a strong predictor of smartphone addiction among college students. Students resort to online interactions to avoid social discomfort in person and use smartphones to escape social problems in the offline world (Kadavala, 2021). However, owing to their poor emotional regulation skills, these individuals tend to choose their smartphones as substitutes for offline social interaction and as tools for emotional regulation. This, combined with their increasing time spent in attractive and comforting digital spaces created through smartphones, which are far from the anxieties of the offline world, can lead them to smartphone addiction (Liu & Baharudin, 2025).

The use of smartphones as a mediator between depression and phubbing

Depressive symptoms lead to excessive use for three reasons: (1) Reduced emotional resources: Depressed individuals use smartphones for distraction and escape, reinforcing compulsive use; (2) Deficits in executive functions: Impairments in cognitive flexibility and impulse control affect behavior modulation, facilitating addictive behavior; and (3) the search for temporary relief: Relief from negative emotions leads to greater offline isolation (Ge et al., 2023; Feng & Dou, 2024) approaching phubbing behavior.

The use of smartphones has become a convenient way to vent the emotional experiences of depression while increasing the tendency toward addiction (Li et al., 2019). Thus, depression presents itself as an important risk factor for behavioral addiction (Sayeed et al., 2020), more specifically, in the present scenario, smartphone addiction.

Mental health as an independent variable

Studies such as that by Feng and Dou (2024) and Wang et al. (2025), which were also conducted with university students, revealed that depression and anxiety, respectively, as predictors of smartphone addiction, contribute to the underexplored perspective of mental health symptoms leading to smartphone addiction and not just the other way around, offering insights into how mental health problems can lead to behavioral addictions associated with technology, such as smartphone addiction and other problems that can arise from them, such as phubbing (Karadag et al., 2015; Bajwa et al., 2023; Zhao et al., 2021a).

Bayesian network analyses provide solid support for the research findings. The probabilistic structure revealed that smartphone addiction acts as a mediator between mental health symptoms and phubbing behavior. Specifically, the model indicates that stress directly influences smartphone addiction, which in turn affects phubbing behavior, confirming the proposed mediation. Furthermore, the hierarchical

relationship between stress, anxiety, and depression reinforces the complexity of the emotional picture that precedes addiction and phubbing behavior.

The moderating role of gender

When faced with negative life events, women are more susceptible to excessive smartphone use for social interaction purposes (Zhao et al., 2021b; Aparicio-Martínez et al., 2020) because they use relationships, social support, and social activities for emotional release through interpersonal communication (Gentry et al., 2007; Tifferet, 2020).

The results may have significant implications for the development of personalized interventions that address mental health and contextual aspects among students of different genders. Such measures may help mitigate smartphone addiction and minimize problematic behaviors (Tu et al., 2023), as noted by Cheng et al. (2024), who proposed that reducing stress reduces smartphone addiction in women.

The moderating role of race

An unexpected finding was also identified: race significantly moderated the relationships between mental health, smartphone addiction, and phubbing. The effects were more pronounced in indigenous people.

The literature on this specific relationship is still scarce; however, Lawal et al. (2021) investigated differences in stress, anxiety, and depression levels among ethnic groups during the COVID-19 pandemic in Canada and reported that indigenous people had higher levels of these symptoms than Caucasians and Asians did. However, mental health data collected from indigenous people should be interpreted with caution since, even if the instruments used are validated for the country where the research was conducted, they are not culturally adapted to the indigenous population, which, even though it resides in these countries, has a holistic view of health and well-being that contrasts with that of the dominant Western biomedical model (Meldrum et al., 2023).

Rice et al. (2016) argued that indigenous youth can use social media to help affirm and strengthen their identities, exercise control over their lives, and build and maintain community and family connections. However, social isolation and a lack of offline social support in academic settings contribute to increased psychological symptoms and smartphone addiction (Al-Kandari & Al-Sejari, 2021).

This complex arrangement of experiences helps us understand how mental health symptoms more intensely affect smartphone addiction and phubbing among indigenous students, especially women. However, findings on this relationship are scarce, especially with respect to phubbing in the indigenous population, which limits more in-depth discussions. Nevertheless, this study brings new initial findings to the field, and future studies should further investigate how the challenges faced by indigenous university students, perceptions of isolation, prejudice, discrimination, and racism, and lack of offline social support moderate the relationship between mental health symptoms and phubbing mediated by smartphone addiction to help elucidate why the impact is greater in this population.

Practical Implications, Limitations, and Future Research

The results of this study have several practical implications, particularly for the development of intervention programs aimed at reducing phubbing behavior and its psychological antecedents. Since smartphone addiction mediates the relationship between mental health symptoms and phubbing and gender and race moderate this mediated relationship, interventions that simultaneously address emotional distress and excessive device use while considering gender and race particularities may be especially effective.

Promoting self-regulation strategies and emotional awareness, such as mindfulness-based interventions, can be developed with special attention to the most affected groups and help students reduce their dependence on smartphones as maladaptive coping mechanisms. Research has suggested that mindfulness can mediate the relationship between anxiety and smartphone addiction (Hallauer et al., 2022), and mindfulness-based programs have been shown to be effective in reducing stress symptoms (Dark-Freudeman et al., 2021), anxiety and depressive symptoms (Moix et al., 2021), and excessive use of smartphones (Lan et al., 2018).

Psychological support services offered at higher education institutions should be expanded to integrate mental health promotion with education on digital behavior. These services should not only help students manage anxiety, depression, and stress but also encourage critical reflection on their smartphone usage patterns. Interventions that include psychoeducation, personalized feedback, and the development of healthier digital routines can help students regain control over their interactions with technology (Santos et al., 2023c).

Universities can play a proactive role by creating environments that promote face-to-face interaction and discourage compulsive smartphone use. Teachers can implement classroom rules that limit phone access and encourage collective reflection on the quality of interpersonal communication group mindfulness activities (Long et al., 2021), especially during periods of academic stress, which can be particularly beneficial for cultivating more meaningful social engagement.

Despite its contributions, this study has several limitations that should be acknowledged. First, the sample was predominantly composed of cisgender women, which may affect the generalizability of the findings. Previous research has suggested that women may be more susceptible to problematic smartphone use and digital emotional regulation strategies, which may influence the associations observed. Future studies should seek more gender-diverse samples to allow for better comparative analyses between demographic groups.

The study focused on a limited set of mental health variables, namely, depression, anxiety, and stress, which were assessed via the DASS-21. Although these are highly relevant constructs, mental health is multifaceted. Future investigations may include additional psychological indicators, such as loneliness, emotional regulation strategies, impulsivity, or personality traits, which have been associated with phubbing in recent studies (Luo et al., 2023; Santos et al., 2023b).

Conclusion

This study investigated the mediating role of smartphone addiction in the relationships between mental health symptoms, specifically anxiety, stress, and depression, and phubbing behavior among university students in the northern region of Brazil. The results confirmed that students with higher levels of psychological distress are more prone to engaging in problematic smartphone use, which, in turn, increases the likelihood of phubbing. Furthermore, the effects of mental health symptoms on smartphone addiction, and subsequently the effects of the latter on phubbing, are stronger in women and indigenous populations.

By identifying smartphone addiction as a fundamental mediating mechanism, this study offers a deeper understanding of how internal emotional vulnerabilities are expressed through external digital behaviors and how gender and race affect the intensity of this relationship. Instead of viewing phubbing as a purely behavioral or superficial phenomenon, these findings frame it as a complex psychosocial outcome shaped by difficulties in emotional regulation and dependence on technology as a coping strategy that relates to sociodemographic variables.

This integrative model has significant implications for both research and practice. It encourages academics to examine digital behavior within a broader emotional, psychological, and social context and highlights the need for interventions that address both emotional well-being and digital literacy, considering contextual issues. In line with the recommendations of Santos et al. (2023c), this triple focus can offer a more comprehensive approach to reducing the negative consequences of phubbing among young adults.

Ultimately, these findings contribute to a growing body of literature on the psychological, behavioral, and social dimensions of smartphone use, offering valuable insights for prevention strategies, university support services, and public health campaigns. The findings of this research provide support for interventions aimed at reducing phubbing and problematic smartphone use among university students with mental health symptoms, emphasizing the need for approaches that consider psychological vulnerabilities and sociodemographic differences. As smartphone addiction acts as a mediator between depressive symptoms, anxiety, stress, and phubbing, psychosocial interventions should prioritize emotional regulation strategies and adaptive coping, especially for more affected groups, such as women and indigenous populations. Psychological support programs in the academic environment, combined with digital literacy, can mitigate the vicious cycle and social isolation. By promoting emotional resilience and responsible technology use, educators and professionals can contribute to connected and healthy university communities.

Declarations

Competing interests

The authors declare that they have no competing interests.

Ethical approval

This study was evaluated by the Human Research Ethics Committee of the Federal University of Amazonas and was approved under opinion No. 5,454,908. All participants were included after reading and accepting the Informed Consent Form (ICF).

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Author Contribution

All authors contributed to the conception and design of the study. Material preparation and data collection were carried out by [Lívia Fernanda Nascimento dos Santos] and [Marck de Souza Torres]. Data analysis was carried out by [Marck de Souza Torres] and [Leandro da Silva Sauer]. Discussion of the results was carried out by [Marck de Souza Torres], [Adriane de Almeida Santos], [Leandro da Silva Sauer]. The first draft of the manuscript was written by [Adriane de Almeida Santos], [Marck de Souza Torres], [Tailson Mariano], [João Gabriel Modesto], and [Fábio Alves Gomes] all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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Data Availability

The datasets generated and/or analyzed during the current study are not publicly available due to the risk of compromising the individual privacy of participants and ethical violations, since participants are protected by a term of guarantee of confidentiality and anonymity.

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Figures

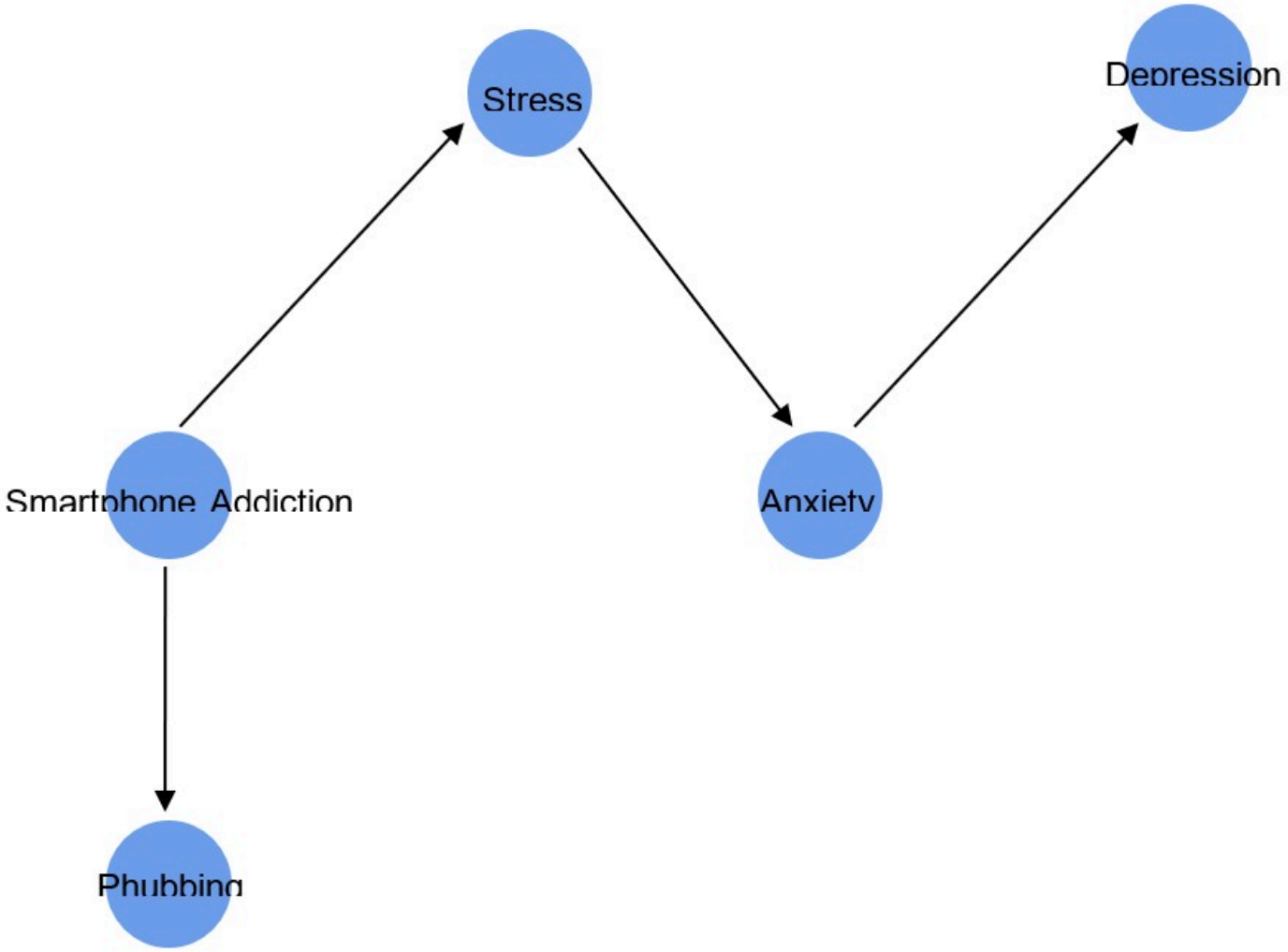


Figure 1

Bayesian network formed from the data