

25-Oct-2024

Trends

in Psychiatry and Psychotherapy

JOURNAL ARTICLE PRE-PROOF **(as accepted)**

Original Article

Smartphone dependence predicts poorer mental health outcomes, eating behaviors, activity levels, and body image: A cluster analysis of Brazilian university students

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<http://doi.org/10.47626/2237-6089-2024-0904>

Original submitted Date: 01-Jul-2024

Accepted Date: 25-Oct-2024

This is a preliminary, unedited version of a manuscript that has been accepted for publication in Trends in Psychiatry and Psychotherapy. As a service to our readers, we are providing this early version of the manuscript. The manuscript will still undergo copyediting, typesetting, and review of the resulting proof before it is published in final form on the SciELO database (www.scielo.br/trends). The final version may present slight differences in relation to the present version.

Smartphone dependence predicts poorer mental health outcomes, eating behaviors, activity levels, and body image: A cluster analysis of Brazilian university students

Short title: Smartphone Dependency Worsens Mental Health

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ABSTRACT

Introduction: Excessive smartphone use has been linked to mental health impairments and may potentially alter human behavior. These effects are particularly pronounced among young individuals, with university students being especially susceptible to the negative influences of smartphone use.

Methods: This observational, cross-sectional study was conducted in a sample of 781 Brazilian university students. We assessed socio-economic variables, smartphone addiction, depression, anxiety, stress outcomes, eating behavior, body image satisfaction, and self-reported physical activity. MANOVA and Chi-square tests were performed to compare continuous and categorical variables between genders. K-means clustering was used to identify participant profiles based on various self-reported variables, with differences between clusters validated using the Z-test and the silhouette coefficient.

Results: Three clusters were identified. Cluster 1 featured participants with a significant disparity between their perceived and desired body image, higher scores on eating disorders, smartphone addiction, and mental health questionnaires, and lower engagement in physical exercise. Cluster 2 consisted of older participants who scored lower on smartphone addiction and mental health with a higher body mass index. Cluster 3 included younger participants with a smaller silhouette scale disparity, lower eating disorder scores, and lower body mass index. Smartphone addiction showed significant associations with eating disorders in overall eating disorders classification ($X^2=13.4$; $p<0.001$), bulimic behavior ($X^2=20.0$; $p<0.001$), and social pressure to eat ($X^2=4.3$; $p<0.001$). It also negatively correlated with physical exercise ($X^2=5.7$; $p=0.017$), but not with dieting concerns ($X^2=0.23$; $p=0.688$).

Conclusion: Smartphone addiction is associated with eating disorders, stress, depression, anxiety, and lower levels of physical activity.

Keywords: Internet Addiction Disorder; Feeding and Eating Disorders; Body image; Anxiety; Depression.

Introduction

Smartphones are considered **the** major screen device used in modern times.¹ These devices facilitate quick research, communication, and online social interaction.² However, despite these advantages, excessive smartphone use has garnered attention due to its potential health detriments.³ Nomophobia, a term used to describe the fear and discomfort caused by the lack of contact or access to a smartphone and/or the internet, is a **phenomenon** that can lead to mood changes, depression, anxiety, social phobia, and other issues.⁴

Smartphone dependence is a disorder not yet recognized in psychiatric manuals and receives less attention compared to substance use disorders.⁵ There is ongoing debate in the literature about whether this behavior should be

classified as an addiction, as its impact on functional impairment may not reach the severity levels associated with other addictions.⁶ Additionally, there is currently no gold standard for diagnostic criteria, which may lead to the potential misclassification of individuals as “smartphone addicted”.⁷ Therefore, this condition is more accurately described as “problematic use” or “dependence.”⁶ Smartphone dependence occurs when individuals become so immersed in smartphone use that they neglect other areas of their lives.⁸ Thus, this dependency is considered a behavioral issue that affects aspects of cognitive, social, and psychological development, particularly in young individuals.⁹⁻¹¹ Additionally, eating and body image disorders are behavioral aspects that may be associated with smartphone dependence.¹² Excessive smartphone use can also lead to unhealthy eating behaviors, such as the consumption of fast food and junk food, and negatively impact physical activity.¹²

University students are prone to smartphone addiction and psychological disorders such as anxiety and depression.^{13,14} However, behavioral, environmental, and cultural factors can influence the relationship between smartphone addiction and behavioral and mental health outcomes.¹⁵ Therefore, assessing these parameters in students from different countries could provide valuable information to aid in the development of interventions aimed at reducing the negative impacts on mental health and quality of life. Thus, we aim to evaluate the relationship between smartphone addiction and mental health outcomes (anxiety, depression, and stress), eating behavior, body image satisfaction, and physical activity among Brazilian university students.

Materials and Methods

Sample

The sample comprised 781 Brazilian university students (410 males and 371 females) enrolled in both public and private institutions. Participants completed an online survey prepared on Google Forms (Alphabet, Mountain View, CA, USA). The survey included a socio-economic questionnaire that collected information on age, gender, marital status (both participant and parents), education level (both participant and parents), physical activity level, prior diagnoses of anxiety and depression, and use of psychotropic medications. Additionally, self-reported anthropometric data on weight and height were collected to calculate body mass index (BMI). Furthermore, participants completed the Smartphone Addiction Inventory (SPAI-BR), the Depression, Anxiety and Stress Scales (DASS-21), the Silhouette Scale, as well as the Eating Attitude Test (EAT-40). Invitations to participate were sent through social networks including Facebook®, Instagram®, and WhatsApp®. An online snowball sampling strategy was employed to recruit as many respondents as possible.

All participants voluntarily provided informed consent online to participate in the study. The exclusion criteria included individuals under 18 years of age, non-students, non-Brazilian Portuguese speakers, and those who did not complete the entire online survey. The study was approved by the Research Ethics Committee of the Federal University of Lavras (COEP) under protocol number 5.379.531.

Instruments

Smartphone dependence was assessed using the Brazilian version of the Smartphone Addiction Inventory (SPAI-BR).¹⁶ This instrument addresses symptoms of withdrawal, excessive usage time, and interference with daily activities. The SPAI-BR consists of 26 dichotomous items (yes and no). A score above 10 points, out of a total of 26 points, was considered indicative of smartphone dependence.¹⁷

The Brazilian version of Depression, Anxiety, and Stress Scales (DASS-21) was used to evaluate participants' levels of depression, anxiety, and stress.¹⁸ This instrument consists of 21 items, each rated on a scale from 0 ("Strongly Disagree") to 3 ("Totally Agree"). Each of the three subscales (depression, anxiety, and stress) contains seven items, and the final classification for each subscale is obtained by summing the respective item scores, with scores of ≥ 10 , ≥ 8 , and ≥ 15 indicating positive classifications for depression, anxiety, and stress, respectively.¹⁸

Body image satisfaction was assessed using the Silhouette Scale for Adults.¹⁹ To determine body image (dis)satisfaction, the difference between the perceived silhouette and the desired silhouette was calculated according to the guidelines of the original instrument.¹⁹

Eating behavior aspects were assessed using the Eating Attitude Test (EAT-40),²⁰ a tool designed to identify the risk of eating disorders. This instrument consists of 40 questions with Likert scale responses ranging from 0 (never) to 5 (always). The response options are inverted for six items (1, 18, 19, 23, 27, and 39). The total score is obtained by summing the responses, ranging from 0 to 200, with higher scores indicating more dysfunctional eating behaviors.

Additionally, this instrument allows for the identification of specific domains of eating behavior: "dieting concern", "bulimic behavior", and "social pressure to eat".²¹

Statistical analysis

Statistical analysis was conducted using SPSS 28.0 and Past4 (PMC) software. Exploratory analysis included mean, standard deviation, median, percentages, and graphical analysis. A significance level of 5% was adopted. Comparison of continuous variables between genders was performed using MANOVA, and the association of categorical variables was tested using the Chi-square test.

Cluster analysis (K-means clustering) was applied to identify participant profiles with similar variables related to self-reported aspects of smartphone addiction, eating disorders, anxiety, depression, stress, physical exercise, and BMI. This analysis is highly useful for understanding the complex nature of multivariate relationships. The following variables were included: age, gender, silhouette scale difference, EAT-40, SPAI-BR, and DASS-21 scores, physical exercise, and BMI. Differences between clusters were described using the Z-test for validation, and test consistency was based on the silhouette coefficient.

Results

Table 1 displays the clinical and demographic characteristics of participants categorized by gender. There were no differences in age, EAT-40, SPAI-BR, and DASS-21 scores, or silhouette scale between genders ($p>0.05$).

The distribution of participants according to geographical region is depicted in Figure 1.

Table 1. Demographic and clinical characteristics of participants divided by gender (n=781).

| Characteristic | | Men (n=410) | Women (n=371) |
|---|---|------------------------|--------------------------|
| Age (years) | mean (DP) | 24,3 (6,7) | 24,7 (7,4) |
| | min-max | 16-65 | 17-65 |
| Marital Status (%) | | | |
| | Divorced/Separated/Single | 30,5 | 30,6 |
| | Married/Common-law Marriage | 69,5 | 69,4 |
| Parental Marital Status During Childhood (%) | | | |
| | Married/Common-law Marriage | 79,8 | 80,3 |
| | Separated/Divorced | 11,0 | 11,9 |
| | Did not grow up with my father/mother | 3,3 | 3,4 |
| Field of Knowledge (%) | | | |
| | Biomedical Sciences | 34,9 | 19,7 |
| | Agricultural Sciences | 14,9 | 4,3 |
| | Applied Social Sciences | 21,5 | 38,8 |
| | Exact and Earth Sciences/Engineering | 21,2 | 26,4 |
| | Humanities, Linguistics, Literature, and Arts | 7,6 | 10,8 |
| | Anxiety/Depression Diagnosis (yes) (%) | % | 52,7 |
| | Physical Exercise Practice (yes) (%) | % | 57,8 |

| | | | |
|--|--------------|-----------|----------|
| 1 time per week | % | 27,8 | 35,6 |
| 2-4 times per week | % | 39,5 | 39,4 |
| 5-7x/ times per week | % | 21,7 | 21,8 |
| BMI classification † | | | |
| Underweight (%) | % | 7,6 | 5,8 |
| Normal Weight (%) | % | 59,3 | 56,7 |
| Overweight (%) | % | 22,5 | 22,8 |
| Obesity | % | 10,6 | 14,6 |
| Actual image | Med (25-75%) | 7 (6-10) | 8 (5-10) |
| Desired image | Med (25-75%) | 6 (5-7) | 6 (5-7) |
| Difference between actual and desired image | Med (25-75%) | 1,5 (0-3) | 2 (0-3) |

SD, standard deviation; Med, median. † Self-report; contains missing data.

Figure 1. Representation of the number of participants by region of the Brazilian territory.



It was observed that 271 participants (34.6%) were classified as having a smartphone addiction, based on the cutoff specified in the Materials and Methods/Sample section (a score of 10 or higher out of 26 on the SPAI-BR). The relative frequency of this condition was higher among women compared to men (Table 2). In the EAT-40, 117 participants (14.9%) were classified as with dysfunctional eating behavior in the overall score, with 29 (3.7%) showing dieting concern, 122 (15.6%) classified with bulimic behavior, and 18 (2.3%) having high scores in social pressure to eat. In the DASS-21, it was observed that 294 (37.6%) participants showed depression, while 327 (41.8%) and 356 (45.5%) were classified with anxiety and stress, respectively. Table 2 presents the frequency data of participants by sex for positive classifications in the SPAI, EAT-40, and DASS-21.

Table 2: Participant characteristics by sex for the observed scores in SPAI, EAT-40, and DASS-21.

| Instrument | Classification/ Domain | | Men (n=410) | Women (n=371) |
|-------------------|-----------------------------------|-------|------------------------|--------------------------|
| SPAI | - | n (%) | 105 (25.6) | 167 (45.0) |
| | Dieting concern | | 16 (3.9) | 13 (3.5) |
| | Bulimic behavior | | 69 (16.8) | 53 (14.3) |
| EAT-40 | Social pressure to eat | n (%) | 13 (3.1) | 5 (1.3) |
| | Total | | 66 (16.1) | 51 (13.7) |
| | Depression | | 159 (38.7) | 135 (36.3) |
| DASS-21 | Anxiety | n (%) | 180 (43.9) | 147 (39.6) |
| | Stress | | 189 (46.1) | 167 (45.0) |

Cluster analysis identified three distinct profiles among the participants that met the criteria for interpretability, varying according to age, body image, self-reported eating disorders, body mass index (BMI), physical exercise practice, symptoms of depression/anxiety/stress, and smartphone addiction, considering the parameter of the achieved Z-test. Table 3 shows that Cluster 1, termed 'Smartphone Addiction,' included participants with a greater discrepancy between their perceived and desired body image (silhouette scale), higher scores on the EAT-40, SPAI-BR, and DASS-21 questionnaires, and a lower frequency of positive responses for physical exercise practice. Cluster 2 (Older Age and Lower Smartphone Addiction) included older participants (average age of 43 years), scored lower on the SPAI and DASS-21 questionnaires, and had a higher BMI. Finally, Cluster 3 (Fewer Eating Disorders) comprised younger participants, with a smaller discrepancy on the silhouette scale, lower scores on the EAT-40 instrument, and lower BMI.

Table 3. Description of the groups (clusters) generated from the study variables (centroids; means). Differences that define the clusters are highlighted in gray.

| | Cluster 1 (Smartphone addiction) | Cluster 2 (Older Age and Lower Smartphone Addiction) | Cluster 3 (Fewer Eating Disorders) | Z | ANOVA p-value |
|-----|--|--|---|-------|------------------|
| N | 211 | 58 | 512 | | |
| Age | 23,2 | 43,9 | 22,8 | 602,6 | <0,001 |
| Sex | 0,5 | 0,6 | 0,5 | 1,6 | 0,211 |

| | | | | | |
|-------------------------|------|------|------|-------|--------|
| Body Image (silhouette) | 2,7 | 2,0 | 0,7 | 43,4 | <0,001 |
| EAT-40 | 31,2 | 16,7 | 15,9 | 397,8 | <0,001 |
| SPAI | 14,4 | 7,6 | 10,2 | 64,2 | <0,001 |
| DASS-21 depression | 13,7 | 3,8 | 6,2 | 189,2 | <0,001 |
| DASS-21 anxiety | 12,0 | 3,2 | 4,8 | 205,4 | <0,001 |
| DASS-21 stress | 15,1 | 6,2 | 8,4 | 178,0 | <0,001 |
| Physical activity | 0,6 | 0,7 | 0,7 | 4,4 | 0,012 |
| BMI | 24,4 | 27,9 | 23,5 | 14,4 | <0,001 |

Silhouette coefficient = 0.30; BMI: Body mass index; DASS-21: Depression, Anxiety and Stress Scales; EAT-40: Eating Attitudes Test-40; SPAI: Smartphone Addiction Inventory;

Indeed, a more detailed analysis revealed that smartphone addiction was significantly associated with the presence of eating disorders in the overall EAT-40 classification ($X^2=13.4$; $p<0.001$), as well as in the domains of bulimic behavior ($X^2=20.0$; $p<0.001$) and social pressure to eat ($X^2=4.3$; $p<0.001$). Smartphone addiction was also negatively associated with physical exercise ($X^2=5.7$; $p=0.017$), but not with concern about dieting ($X^2=0.23$; $p=0.688$).

Discussion

The main findings of this study include the definition of participant profiles based on sociodemographic and clinical characteristics, resulting in the identification of three clusters: "smartphone addiction," "older age and lower smartphone addiction," and "fewer eating disorders." Through cluster analysis, it was possible to identify that those participants with higher smartphone dependency exhibited greater body image distortion and a higher risk of developing eating and psychological disorders (anxiety, depression, and stress),

in addition to being less engaged in physical exercise. Additionally, the study identified a significant association between smartphone addiction and overall EAT-40 scores, as well as with bulimic behavior and social pressure to eat. Another noteworthy finding was the negative association between smartphone addiction and self-reported physical activity.

Cluster analysis is a highly effective tool for identifying patterns within specific groups based on sociodemographic and behavioral characteristics.²² Additionally, this analysis provides a screening of mental health indicators, serving as a crucial starting point for establishing therapeutic and preventive strategies by considering the determinants of specific issues.²³ As found in the present study, higher smartphone dependency has been associated with poorer mental health outcomes.²⁴ In a study conducted with nursing students, it was reported that anxiety and depression levels were higher among participants classified as having smartphone addiction.²⁴ Smartphone addiction is believed to have a bidirectional relationship with anxiety and depression, with nomophobia being a risk factor for developing these disorders.²⁵ Conversely, individuals with anxiety and depression are more prone to becoming dependent on their devices.²⁵

Considering the profile of individuals in Cluster 1, greater discrepancies were observed between the current silhouette and the desired silhouette, indicating higher body image dissatisfaction. Body image dissatisfaction is a common trait among anxious and depressed individuals,²⁶ aligning with the characteristics observed in the present study. Additionally, smartphone dependency has been associated with body image distortion among Korean adolescents.²⁶ This relationship may be explained by the content accessed on

these devices by younger individuals, who primarily use them to access social media.²⁷ Social media platforms often promote the idealization of an ideal body type, with thinness for women and muscularity for men.^{27,28} Thus, even though this relationship is more evident in adolescents²⁶⁻²⁸ young adults may also exhibit these behaviors, influencing their body image satisfaction as observed in the present study.

Regarding eating behavior, in our study individuals located in Cluster 1 exhibited higher scores on the EAT-40, which were associated with increased anxiety, depression, body dissatisfaction, and smartphone dependency. Additionally, Cluster 3 (Less eating disorders) included participants with lower scores on eating disorder measures, lower body dissatisfaction, and lower BMI values. The behavior observed in these clusters is consistent, given that body dissatisfaction is a predominant factor in eating disorders.²⁶

To the best of our knowledge, few studies have explored the relationship between smartphone addiction and higher scores in the domains of bulimic behavior and social pressure to eat. Previous studies have reported similar findings regarding the association between smartphone addiction and overall scores on the EAT-40.^{3,28} Among university students, it has been observed that longer internet and smartphone usage correlates with higher EAT-40 scores.² Additionally, students with smartphone dependence have shown higher scores on the abbreviated version of the EAT (EAT-26).³ It is described in the literature that individuals with internet addiction are more likely to meet the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria for bulimia, with depression considered as a mediator in this relationship.²⁹ Furthermore, social media addiction has also been weakly associated with increased risk of

developing bulimia.³⁰ These prior findings support the results of the present study, as smartphones are currently the primary means of internet access for most individuals.

Regarding the association between smartphone addiction and higher scores in the domain of "social pressure to eat," it is conceivable that because a substantial portion of smartphone use revolves around accessing social networks, young individuals are exposed to comments and criticisms regarding their bodies, thereby feeling compelled to uphold thinness standards.^{31,32}

An interesting finding of the present study was the negative association between smartphone addiction and physical exercise. While the content accessed on smartphones can serve as a motivator for physical activity, their addiction appears to increase sedentary behavior (e.g., prolonged sitting) and reduce the quality and quantity of moderate and vigorous physical activities.^{33,34} A similar trend was observed in a sample of Chinese students, where engaging in physical activity was considered a protective factor against the onset of smartphone dependency.³⁵

Conclusion

Based on the results observed in the present study, we conclude that smartphone addiction is associated with eating disorders, stress, depression, anxiety, and lower levels of physical activity. These findings underscore the need for interventions aimed at limiting screen time among university students, as these outcomes could negatively impact quality of life and academic performance. Future studies should include an investigation of the content

accessed and explore whether there is a relationship between this content and other behavioral and mental health outcomes.

Author contributions: CRediT Taxonomy Karen Lima Investigation-Equal, Methodology-Equal, Writing - original draft-Equal, Writing - review & editing-Equal Bárbara Amorim Investigation-Equal, Methodology-Equal, Writing - original draft-Equal, Writing - review & editing-Equal Débora Orlando Investigation-Equal, Methodology-Equal, Visualization-Equal, Writing - original draft-Equal, Writing - review & editing-Equal Luciano Pereira Investigation-Equal, Methodology-Equal, Visualization-Equal, Writing - original draft-Equal, Writing - review & editing-Equal Paula Castelo Data curation-Equal, Formal analysis-Equal, Investigation-Equal, Methodology-Equal, Resources-Equal, Software-Equal, Validation-Equal, Writing - original draft-Equal, Writing - review & editing-Equal Eric Francelino Andrade Conceptualization-Lead, Investigation-Equal, Methodology-Equal, Project administration-Lead, Supervision-Lead, Writing - original draft-Equal, Writing - review & editing-Equal.

Handling Editor: Dr. Thiago Roza

Source support: This study did not receive specific funding.

Conflict of interest declaration: The authors declare no conflict of interest.

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