Factors related to smartphone addiction in adolescents from a region in Northeastern Brazil

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Abstract *Adverse effects on the physical and mental health of adolescents associated with excessive smartphone use have been reported. This paper aims to assess adolescent smartphone addiction and related factors in a region in Northeastern Brazil. This cross-sectional study was carried out in six State-run Professional Education Schools in Fortaleza, Ceará, Brazil, from September to October 2019 with 286 adolescents aged 15-19 years who completed five data collection instruments. Bivariate and multivariate analyses were performed to assess factors related to the outcome using SPSS version 23.0. Smartphone addiction prevalence rate was 70,3% and was associated with being underage (OR=0,583; p=0,001), fewer sleep hours (OR=0,715; p=0,020), longer use on weekends (OR=1,115; p=0,015), cervical pain (OR=2,206; p=0,020), and suspected common mental disorder (OR=1,272; p=0,000). A high smartphone addiction level was observed among adolescents in the sample and was related to multiple factors. Attention should be drawn to the importance of educational campaigns to guide adolescents, parents, educators, and health professionals about the risks of excessive smartphone use to the health of adolescents.*

Key words *Addiction medicine, Smartphone, Risk factors, Adolescents*

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Introduction

The last decades have endured a social transition that has changed society's way of thinking, communicating, relating, and working through digital transformation. Technology allows different people to communicate at the same time, connected in a single network but physically distant. The smartphone is among the technological devices most widely used to access the internet[1].

The number of smartphone users is growing exponentially globally, regardless of age[2]. Data point to a 54% increase in smartphone use as the primary internet access by the population, according to a survey in 21 emerging countries[3]. In this scenario, Brazil ranks second globally concerning the daily internet connection time, at nine hours[4]. Another survey directed at children and adolescents informs that 86% access the internet through this device[5].

Such growth is associated with several resources such as communication and entertainment, which are compressed on the same device[6]. Easy access has advantages such as increased productivity, instant dissemination of information, and greater pleasure in using social networks. Studies show that people use smartphones excessively, highlighting adolescents as a risk group regarding prolonged use[7].

This device is convenient to its users. However, its prolonged use causes problems that compromise health conditions[8]. The literature describes smartphone addiction as a behavioral disorder characterized by impulsiveness and uncontrollable use as a constant display of notifications, games, and applications, compared to other behavioral dependencies. While there is no specific classification within the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), this behavior adversely affects adolescent biopsychosocial aspects[9].

Adolescents are strongly tied to their smartphones and say they cannot live without their devices. These digital natives often use them addictively, following fashioned use of applications and searching for relationships and emotional support. They commonly express their thoughts in a virtual recreation environment, looking for instant reactions and feedbacks[10].

Given the scenario presented, the need to foster data related to the excessive use of the smartphone and its consequences to direct actions and fill gaps is highlighted, as previously warned by the WHO[11]. Thus, this study aimed to assess smartphone addiction and related factors in adolescents from the Brazilian Northeast.

Methods

This is a quantitative, cross-sectional, and analytical study nested in a research project entitled *Study of postural and painful changes in the cervical region associated with the use of smartphones in adolescents*, developed at State Professional Education Schools (EEEPs) at the high school level, in Fortaleza, Ceará, Brazil. Recruitment and data collection were carried out in August and September 2019.

Fortaleza, capital of Ceará, is the fifth-most populous Brazilian city, with a population of 2,643,247 inhabitants. Its municipal HDI is 0.754 and that of Education 0.692, ranking 17th in the HDI ranking of the country's metropolises[12]. Since 1997, it has been administratively divided into seven Regional Executive Secretariats (SER) and currently houses 119 neighborhoods in five districts[13].

In 2008, EEEPs were established in Ceará to integrate high school and full-time professional education. For the study, the selection was made by conglomerate in two stages. Six schools were selected by draw in the first stage, one in each SER, except for the SER Centro, which does not have one. In the second stage, one class per grade (first to third) was selected, morning or afternoon shifts, totaling three classes per EEEP. At least 13 adolescents were recruited per class in each.

Two hundred ninety-one adolescents (15-19 years) were selected, attending the first to third high school grades, enrolled in the 2019 academic year in the selected EEEPs, with a smartphone, composing a probabilistic sample. Five students were excluded from this total because they did complete one of the collection instruments or due to the lack of anthropometric data and were considered sample losses. As a result, the final sample included 286 adolescents, equally distributed among grades (96 from the first grade, 95 from the second grade, and 95 from the third grade of high school).

We excluded those who did not attend classes on the days of data collection, had a self-reported diagnosis of scoliosis, fracture or degenerative injuries in the cervical spine, recent traumatic injuries, and people with physical disabilities due to factors related to postural and painful spine changes, pregnant women due to physiological changes, and people with visual, hearing, and cognitive impairments due to the lack of adaptability of the collection instruments for this population and their self-completion.

The number of participants was estimated by sample calculation, considering a finite pop-

ulation (n=224,153) of adolescents (15-19 years) from Fortaleza[12], 18% prevalence of cervical pain in users of mobile devices[2], sampling precision of 5%, 95% confidence interval, and 10% increase for sample loss. The series and age range listed for this study were based on the recommendations of the National School Health Survey (PENSE)[14]. The school has an essential influence on the up-bringing of adolescents in the cognitive, social, and emotional development stage; therefore, it is a favorable environment for monitoring risk factors and protecting the population[14].

After authorization from the school directors, the recruitment of participants started by public call for an explanatory lecture addressed to parents/guardians and adolescents. Then, consent was requested by signing the informed consent and assent forms (ICF). Data were collected in two stages. In the first stage, they answered five self-applicable data collection instruments, in the school's classroom, at a specific time set by the director to ensure non-interference in school activities.

The collection instruments applied were: 1) Sociodemographic and health conditions questionnaire; 2) International Physical Activity Questionnaire short version (IPAQ); 3) Nordic Musculoskeletal Symptoms Questionnaire (NMQ), 4) Self-Report Questionnaire (SRQ-20); and 5) Smartphone Addiction Inventory (SPAI-BR).

The researchers developed the sociodemographic and health conditions questionnaire, which collected sociodemographic data (age, gender, ethnicity, living with, social class, maternal and paternal schooling) and health history (sleep characteristics and self-assessed health).

The IPAQ short version, validated in Brazil for use in adolescents, adults, and older adults, consists of eight open-ended questions that estimate the weekly time spent in different physical activity dimensions (walking and moderate/vigorous-intensity physical efforts) and sedentary behavior (sitting position)[15]. Two categories were used in this study to classify the physical activity level: non-sedentary (very active, active, irregularly active) and sedentary[16].

The Nordic Musculoskeletal Symptoms Questionnaire, validated[17] and cross-culturally adapted[18] to Portuguese, measures reported musculoskeletal pain/symptoms (yes/no) in nine anatomical regions (cervical, shoulders, chest, elbows, wrists/hands, lumbar region, hips/thighs, knees, and ankles/feet) in the last seven days.

The SRQ-20, validated for Portuguese, is an instrument that identifies psychosomatic symptoms for the screening of Common Mental Disorder (CMD). It is recognized by the World Health Organization and validated in Brazil[19]. It consists of twenty questions in four groups of symptoms referred in the last thirty days with yes/no answers. In this study, we employed the sum of the answers marked as "yes" (numerical variable), and a cut-off point ≥ 8 points for suspected CMD (categorical variable) was used, with a sensitivity of 86.3% and specificity of 89.3%[20].

The SPAI-BR is an instrument with 26 items, divided into four subscales, with a yes/no answer to assess smartphone addiction. The cut-off point adopted for smartphone addiction was seven points, which has a sensitivity of 90.54% and specificity of 59.93% for validation and adaptation to Portuguese[21]. Two questions were added at the end of the instrument about smartphone use hours on weekdays and weekends.

We performed the anthropometric assessment (weight and height) to calculate the BMI (Kg/cm^2) in the second stage. Weight was measured using an Omron portable digital scale, with a capacity of up to 150 kg, calibrated and positioned on a firm surface. Height was gauged with a duly calibrated compact Macrosul portable stadiometer. BMI was classified in the presence or absence of overweight as per the table proposed by the World Health Organization[22].

The data were analyzed using descriptive and inferential statistics using SPSS Statistics IBM® version 23.0. The univariate analysis calculated the absolute (n) and relative (%) values of the categorical variables and the means ± standard deviations (SD) of the numerical variables. Pearson's chi-square was applied to analyze factors related to smartphone addiction, followed by calculation of the crude ORs and respective 95% confidence intervals, and Student's t-test, after normality test. Then, a multivariate logistic regression was performed by the stepwise backward method, selecting the variables with a level of significance of up to 20% in the bivariate analysis (p<0.020), allowing the selection of relevant variables for the model and controlling for confounding variables, as proposed by Hosmer and Lemeshow[23]. Variables with a 5% significance level (p<0.05) remained in the final model, calculating the adjusted ORs and their 95% confidence intervals.

The study was approved by the Human Research Ethics Committee of the University of Fortaleza (COÉTICA/UNIFOR) under Opinion N° 3.341.394, as per Resolution N° 466/12 of the National Health Council. Parents/guardians and

adolescents consented to their participation by signing the consent terms.

Results

Regarding socioeconomic variables, there was a higher proportion of adolescents aged 16 (n=90; 31.5%), male (n=152; 53.1%), from social class D (n=150; 52.4 %) and with parents with high school education (n=142; 49.6% for the mother and n=127; 44.4% for the father). Concerning health conditions, they slept on average 6.8 (±1.1) daily hours, 40.2% (n=115) were sedentary, 47.6% (n=136) complained of cervical pain, and 23.1% (n=66) were overweight. Of the total, 70.3% (n=201) were smartphone addicts and used it for 5.8 hours (±3.5) and for 8.8 hours (±5.0) on weekdays and weekends, respectively (Table 1).

In the bivariate analysis, smartphone addiction was related to complaints of pain in the cervical (OR=2.960; p=0.000), upper back (OR=1.950; p=0.010) and wrist (OR=1.956; p=0.029) regions, age (16.1 ± 0.9; p=0.008), sleep hours (6.6 ± 1.1; p=0.001), weekend use time (9.4 ± 5.3; p=0.000) and suspected CMD (8.7 ± 4.5; p=0.000) (Tables 2 and 3). In the multivariate analysis, smartphone addiction was associated with complaints of cervical pain (OR=2.206; p=0.020), younger age (OR=0.583; p=0.001), fewer sleep hours (OR=0.715; p=0.020), more use time on weekends (OR=1.115; p=0.015) and suspected CMD (OR=1.272; p=0.000) (Table 4).

Discussion

This study investigated an emerging theme, focused on the epidemiological and health promotion fields, which involves smartphone addiction by adolescents and the associated factors. This particular population is strongly attracted by technology, staying for long hours connected to the internet and social networks, among other virtual environments[11]. The smartphone is one of the primary means of accessing the internet[5] among the current mobile devices.

As a result, there is growing concern about understanding the behavior and addiction of the internet, video games, and smartphones. Internet use and the interaction with online content/activities are historically considered global addictions. Given this scenario, with the possibility of connecting and offering applications, the emergence of the smartphone becomes a potentially addictive device[9].

Concerned about these issues, the WHO declared that the excessive and problematic use of electronic devices, including the smartphone, is a global public health problem and encouraged research to provide scientific evidence on the factors involved in this behavior and possible harm to users' health[11].

The problematic use of the smartphone can be investigated by specific instruments that analyze the dependence/addiction and measure this device's use time. Both variables were investigated in this study, and it was found that 70.3% of the sample was dependent on the smartphone, and the use times were 5h 48 minutes on weekdays and 8h 48 minutes on weekends. Also, adolescents with smartphone addiction had more time on weekends than those not addicted.

The prevalence found was higher than others reported with adolescents in different countries, 55% in Taiwan[24], 50.6% in Turkey[25], 30.9% in South Korea[6], and 16.9% in Switzerland[26]. In Brazil, a previous study for adaptation and validation of the Smartphone Addiction Inventory pointed to a prevalence of 35% in a young population (18-25 years)[21]. This high value can be justified by the increased access of Brazilian adolescents to the internet and its resources, primarily through their smartphones[5,14]. Furthermore, the risk of bias is mitigated, using an instrument cross-culturally adapted to the Portuguese language.

Adolescent's smartphone use time should also be monitored due to its direct relationship with the addiction to this device[27]. Previous studies in Korea[6] and Switzerland[26] have shown use times similar to those found in our study, with 5.2 hours and 5.6 hours, respectively. Unlike previous data, a lower use time was found in a study carried out in the United Kingdom, with 3.1 hours/day[28].

This study found that smartphone addiction was associated with age. In line with age, a survey in Switzerland found that smartphone addiction was more prevalent in younger adolescents (15-16 years) than young adults (19 years and older)[26]. This generation is known to face different stressors more than any previous generation. Besides the physiological changes inherent to adolescence, there is pressure to expose own daily life in the virtual environment, requiring more time online. The excessive use of smartphones and online games aims to minimize stressors, such as school demands, future uncertainties, family and social pressures, leading this population to addictive behaviors[8].

Table 1. Distribution of the investigated variables of adolescents from full-time schools. Fortaleza, Ceará, 2019.

Variables	n	%	Mean + SD
Sociodemographic variables			
Age			
15	80	28.0	
16	90	31.5	
17	88	30.8	
18	22	7.7	
19	6	2.1	
Gender			
Male	152	53.1	
Female	134	46.9	
Self-reported ethnicity			
Brown	154	53.8	
White	72	25.2	
Black	39	13.6	
Yellow	12	4.2	
Indigenous	9	3.1	
Living with			
Both parents	178	62.2	
Only with the mother	77	26.9	
Only with the father	4	1.4	
Other	27	9.4	
Social class			
A	3	1.0	
B	6	2.1	
C	37	12.9	
D	150	52.4	
E	90	31.5	
Maternal schooling			
Elementary school	80	28	
High school	142	49.6	
Higher education	50	17.5	
Did Not answer	14	4.9	
Paternal schooling			
Elementary school	95	33.2	
High school	127	44.4	
Higher education	25	8.8	
Did Not answer	39	13.6	
Health conditions			
Sleeping well			
No	195	68.2	
Yes	91	31.8	

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Table 1. Distribution of the investigated variables of adolescents from full-time schools. Fortaleza, Ceará, 2019.

Variables	n	%	Mean + SD
Sleep hours			6.8 ± 1.1
Health self-assessment			
Good	160	55.9	
Poor	126	44.1	
Physical activity level			
Non sedentary	171	59.8	
Sedentary	115	40.2	
Pain complaint			
Cervical			
No	150	52.4	
Yes	136	47.6	
Shoulder			
No	196	68.5	
Yes	90	31.5	
Upper back			
No	135	47.2	
Yes	151	52.8	
Lower back			
No	141	49.3	
Yes	145	50.7	
Elbow			
No	276	96.5	
Yes	10	3.5	
Wrist			
No	203	71.0	
Yes	83	29.0	
Suspected Common Mental Disorder			
No	136	47.6	
Yes	150	52.4	
Smartphone use			
Smartphone addiction			
No	85	29.7	
Yes	201	70.3	
Smartphone use time on working days			5.8 ± 3.5
Smartphone use time on weekends			8.8 ± 5.0
Overweight			
No	220	79.9	
Yes	66	23.1	

SD: Standard Deviation.

Source: Study data, 2019.

Other factors were also associated with smartphone addiction, such as less sleep, cervical pain, and common mental disorder. Concerning the physical and mental health aspects, a review study listed the multiple health problems from the excessive use of the smartphone, such as de-

Table 2. Bivariate analysis of the association between smartphone addiction and variables, gender, health conditions, activity level, pain complaint, and overweight of adolescents from full-time schools. Fortaleza, Ceará, 2019.

Variables	Smartphone addiction n (%)		Crude OR (95% CI)	p-value
	no	yes		
Gender				0.131[a]
Male	51 (60.0)	101 (50.2)	1	
Female	34 (40.0)	100 (49.8)	1.485 (0.888-2.484)	
Sleeping well				0.050[a]
Yes	20 (23.5)	71 (35.3)	1	
No	65 (76.5)	130 (64.7)	1.775 (0.995-3.166)	
Health self-assessment				0.156[a]
Good	53 (62.4)	107 (53.2)	1	
Poor	32 (37.6)	94 (46.8)	1.455 (0.866-2.445)	
Physical activity level				0.058[a]
Non sedentary	58 (68.2)	113 (56.2)	1	
Sedentary	27 (31.8)	88 (43.8)	1.673 (0.980-2.856)	
Pain complaint				
Cervical				0.000*
No	60 (70.6)	90 (44.8)	1	
Yes	25 (29.4)	111 (55.2)	2.960 (1.720-5.095)	
Shoulder				0.109[a]
No	64 (75.3)	132 (65.7)	1	
Yes	21 (24.7)	69 (34.3)	1.593 (0.899-2.824)	
Upper back				0.010*
No	50 (58.8)	85 (42.3)	1	
Yes	35 (41.2)	116 (57.7)	1.950 (1.165-3.262)	
Lower back				0.066[a]
No	49 (57.6)	92 (45.8)	1	
Yes	36 (42.4)	109 (54.2)	1.613 (0.966-2.691)	
Elbow				0.153[a]
No	80 (94.1)	196 (97.5)	1	
Yes	5 (5.9)	5 (2.5)	0.408 (0.115-1.448)	
Wrist				0.029*
No	68 (80.0)	135 (67.2)	1	
Yes	17 (20.0)	66 (32.8)	1.956 (1.065-3.590)	
Overweight				0.098[a]
No	60 (70.6)	160 (79.6)	1	
Yes	25 (29.4)	41 (20.4)	0.615 (0.345-1.097)	

OR: odds ratio. 95% CI: 95% confidence interval. *p<0.05. Chi-square test. [a] variables selected for logistic regression.

Source: Study data, 2019.

pression, anxiety, impulsivity, sedentary behavior, sleep disorder, contracture in the muscles, and pain in the cervical and lumbar spine[8].

Several studies address the association between smartphone addiction and sleep quality. Studies in Switzerland[29] and Brazil[30] found that smartphone users sleep less, especially on weekdays, and report more sleep problems. Another study in Indonesia revealed that the excessive use of the smartphone at night could lead to sleep disorders and contribute to the onset of depression[27]. The impacts of the excessive use of this device on the quality of sleep and its duration are of concern since sleep restriction can cause physical and mental disorders, and conscious and monitored use is essential.

Table 3. Bivariate analysis of the relationship between smartphone addiction and variables age, sleep hours, smartphone use and suspected common mental disorder of adolescents from full-time schools. Fortaleza, Ceará, 2019.

Variables	Smartphone addiction (mean ± SD)		p-value
	No	Yes	
Age (years)	16.5 ± 1.1	16.1 ± 0.9	0.008*
Sleep hours	7.1 ± 1. 1	6.6 ± 1.1	0.001*
Smartphone use time on working days	5.7 ± 3.5	5.9 ± 3.5	0.613
Smartphone use time on weekends	7.3 ± 3.6	9.4 ± 5.3	0.000*
Common Mental Disorder	4.9 ± 3.4	8.7 ± 4.5	0.000*

SD: Standard Deviation.

Source: Study data, 2019.

Table 4. Multivariate analysis of the relationship between smartphone addiction and study variables in adolescents from full-time schools. Fortaleza, Ceará, 2019.

Variables	Adjusted OR (95% CI)	p-value
Gender (female)	0.600 (0.305-1.183)	0.140
Sleeping well (no)	0.573 (0.258-1.270)	0.170
Health self-assessment (poor)	0.685 (0.349-1.348)	0.274
Physical activity (sedentary)	1.662 (0.855-3.232)	0.134
Pain complaint		
Cervical (yes)	2.206 (1.131-4.302)	0.020*
Shoulder (yes)	1.085 (0.507-2.324)	0.833
Upper back (yes)	1.533 (0.770-3.052)	0.223
Lower back (yes)	1.025 (0.537-1.956)	0.939
Elbow (yes)	0.526 (0.110-2.506)	0.420
Wrist (yes)	1.137 (0.540-2.395)	0.735
Age	0.583 (0.426-0.799)	0.001*
Sleep hours	0.715 (0.538-0.949)	0.020*
Smartphone use time on weekends	1.115 (1.022-1.217)	0.015*
Common Mental Disorder	1.272 (1.150-1.407)	0.000*
Overweight (yes)	0.905 (0.411-1.994)	0.804

OR: odds ratio; 95% CI: 95% confidence interval. Final model parameters: Cox & Snell=0.259; Nagelkerke=0.368; model χ^2=85.854. *p<0.05.

Source: Study data, 2019.

Among the physical repercussions related to the outcome, the adolescents in the sample reported pain in the cervical region. A similar complaint was reported by Taiwanese adolescents who reported musculoskeletal discomfort in the cervical and thoracic spine when using the smartphone for more than three daily hours[31]. Another research carried out in Lebanon found a relationship between musculoskeletal pain in the cervical and pain in the back region using smartphones or tablets due to excessive flexion after 5-7 hours on these devices[32]. In China, in adolescents with a mean age of 18 years, the region of the body with the most significant pain was the cervical region after prolonged use of the smartphone[33].

Regarding the mental health aspect, 52.4% of the sample had suspected CMD, which was related to the outcome of smartphone addiction. Previous research carried out in Hungary[34] and Turkey[25] concluded that the smartphone's time is directly related to impulsivity, anxiety, depression, interpersonal sensitivity, and hostility symptoms. Convergingly, two other cross-sectional studies in Japan[35] and Korea[36] attest that the longer the use, the greater the risk of depressive symptoms and suicidal thoughts.

The findings alert to the importance of monitoring the excessive smartphone use by adolescents and the possible harm to mental and physical health. There is a need to implement health prevention/care programs aimed at these issues with the involvement of the family, educational environments, and the health system. The Brazilian Society of Pediatrics reinforces awareness of the laws in force in the country and the implementation of public policies, culminating in health education campaigns and support materials for the comprehensive protection and prevention of the risks of using the internet and social networks, games, and other applications[37].

Some sample limitations are recognized in this study, such as the non-inclusion of private schools hindering analyses involving socioeconomic factors and the delimitation of the age group (15-19 years). While these limitations potentially affect generalizations of the results, the research findings will contribute to discussing the topic.

Conclusion

This study aimed to assess smartphone addiction and associated factors in adolescents and found a high prevalence among adolescents in the sample and its relationship with multiple factors, such as age, use time, and impairment of physical health conditions, evidenced by the complaint of cervical pain and harm to mental health with fewer sleep hours and evidence of a common mental disorder.

The results can be elucidated by the peculiarities inherent to adolescence, such as the study routine and the need to use the internet for research purposes and its use for leisure moments such as watching movies, games, and relating to other people. Thus, the studied population can develop this behavioral disorder due to these particularities.

Therefore, given the results, the importance of education and health promotion campaigns in various socio-educational settings and the media is highlighted to sensitize adolescents, parents, educators, and health professionals regarding the risks of smartphone addiction to physical health mental and raise awareness of the proper use of this device.

Collaborations

PPB Nunes, APV Abdon, CB Brito, FVM Silva and DQ Martins: substantial contribution in the design and planning, in the acquisition, analysis, and interpretation of data; in the writing and elaboration of the paper; and the approval of the final version. ICA Santos e PMF Meira: substantial contribution in the acquisition of data, in the writing and elaboration of the paper; and the approval of the final version. MA Frota: substantial contribution to the design and planning; in the writing and elaboration of the paper; and the approval of the final version.

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