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Dependence on the use of technologies and daytime sleepiness in adolescent students

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ABSTRACT

Introduction: Over the past 50 years, there has been a decline in average sleep duration and quality, with adverse consequences for overall health. Growing evidence from countries around the world shows the negative impact of using internet access technologies on sleep due to the short wavelength enriched light emitted by these electronic devices. **Objective:** To analyze the exposure to modern technologies/internet and its relationship with the state of daytime sleepiness in teenage high school students. **Methods:** a survey was conducted in six public schools located in the northeast of Brazil. The sample consisted of 1,130 students (mean age 16.6 years ± 1.1). The data collection instrument used was an objective criterion. The characteristic analytical study and quantitative interpretation. Quantitative variables were expressed as mean and standard deviation. For association analyses, the chi-square test or Student's t-test was used. It was considered significant $p<0.05$. **Results:** We found that 7% and 31.6% of the participants reported a state of sleepiness during and after classes, respectively. 59.3% report using the internet excessively, 39.9% have a feeling of dependence, 32.6% report sleep deprivation due to excessive internet use, and 26.7% are unsuccessful in trying to reduce the use of cell phones. **Conclusion:** The relationships between the variables in this study will allow us, the younger students use internet access equipment, the more they are exposed to the risk of sleep impairment.

Keywords: adolescent; schools; internet; sleepiness.

INTRODUCTION

With the technological development that has occurred during the 21st century, Screen time has become an integral part of adolescents' lives, placing a premium on technological connectivity and constant exposure to the World Wide Web. Not surprisingly, technology devices such as computers, Mobile phones /smartphones (MP), video games, tablets, and e-readers are increasingly being used by adolescents before bedtime[1]. Importantly, such devices are being discussed as being harmful to health due to the emission of blue light waves from Light Emitting Diode (LED) screens[2].

During adolescence, new habits are formed that may be relevant to the development and maintenance of the lifestyle of individuals. Among the health-related habits

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acquired during adolescence, the quality of sleep has been the subject of research that aimed to associate the variable with sedentary behavior, screen time, food, and among others[3].

LeBourgeois et al.[4] state that there are adverse associations between the use of a-technology and sleep quality through delayed bedtime and reduced total sleep duration. This total reduction and poor sleep quality are associated with daytime fatigue, which in turn is related to a host of negative outcomes, including poor school performance and a range of psychological problems[5-7].

It should be noted that terms such as insufficient sleep, inadequate sleep, short sleep duration, sleep loss, and sleep restriction are used interchangeably and only as generic descriptive terms and do not imply specific amounts, but rather "less sleep than needed" and in the end translate into an altered waking state with the presence or absence of daytime sleepiness[8].

Over the past 50 years, there has been a decline in the average duration and quality of sleep, with adverse consequences for overall health. Growing evidence from countries around the world shows the negative impact of Internet access technology use on sleep due to the short wavelength enriched light emitted by this electronic devices[6].

Considering the increase in the dependence on HT, the voracity with which they are manufactured, and the resources made available, such as tools for communication, information transfer, and watching and recording videos, among others, it is important to verify what is the impact of the excessive use of this electronic device on the quality of life of individuals, particularly about social/interpersonal adversities, health, both physical and psychological, among other consequences[9].

Given this, this study aimed to analyze exposure to modern technologies/the internet and its relationship with daytime sleepiness in adolescent high school students.

METHODS

This was a cross-sectional epidemiological study with a quantitative methodological approach. The research was developed in schools of the state public education network located in the city of Fortaleza, Ceará, Brazil. The State Education Department of Ceará (SEDUC-CE) decentralizes the functional organization of state schools in the city of Fortaleza-Ce, in three sectors called: Superintendence of the Schools of Fortaleza (SEFOR) 01; 02, and 03. Among these, SEFOR 02 was chosen because it encompasses a larger number of regular schools, being the main service/model of access to basic education offered by the state.

For the selection of schools within SEFOR 02, the indicators presented by the Basic Education Development Index (IDEB) were used, in its last evaluation report conducted in 2017. None of the schools in the network evaluated had a satisfactory score (above six points), while the lowest score recorded was three points. The following score ranges were determined for the choice of schools: 3.0 - 3.9; 4.0 - 4.9, and < 4.9. It should also be noted that SEFOR 02 monitors two regions (regional II and VI) of the municipality, so by selecting one school per IDEB score range and per regional, we have a total of six schools.

The research population comprised the sum of students enrolled in the schools selected as the study scenario in 2019, resulting in a total of 3,721 students. This information on the total number of students enrolled was provided by SEDUC-CE.

Since this is a cross-sectional study, the sample size calculation was performed using the equation: $n=P \times Q /(E/1.96)^2$, where n is the minimum sample size required; P is the prevalence; Q= 100 - P; and E is the tolerated margin of sampling error. Thus, with a standard error of 5%, a confidence interval of 95%, and a P of 50%, a value of 349 was reached, which is equivalent to the minimum number of students required to compose the sample. In this study, a final sample of 1,130 students was obtained. Considering the population and the sample of this study, for a confidence level of 95% we have a margin of error of 2%.

The sample was randomly selected, with a conglomerate (school) stratified by sex and age range from 14 to 18 years (mean age 16.6 years ± 1.1). The inclusion criteria adopted were being regularly enrolled and attending school. Exclusion criteria were not presenting motor, physical or mental difficulties that prevented them from reading and filling out the study instrument.

In this study, we chose to use a self-administered objective questionnaire, multiple choice, and yes/no questions. The instrument was developed from the adaptation of the "Global School-Based Student Health Survey (GSHS)" questionnaire translated into Portuguese by the World Health Organization[10]; the "Internet Addiction Test (IAT)" questionnaire by Conti et al. [11]The "Teenage Sleepiness Questionnaire (CASQ)" by Pinto et al.[12], also with extractions of questions that provide a diagnosis on the state of excessive daytime sleepiness (EDS) of the young schoolchild.

The students were approached in the classroom, where, in agreement with the teacher responsible for the application of the instrument, they were given 50 minutes/1 per class hour to answer the questions. Before handing out the questionnaire, the researcher explained to the students the purpose of the study and how to fill out the questionnaire. The data were collected in the period from September to November 2019. One visit was made in each shift of the school (morning, afternoon, and evening), totaling 18 visits during the entire data collection process.

Table 1 details the profile of the sample in the following aspects: age, gender, level of education, professional activity, and family income. The values show a similar distribution between the male and female sexes on the level of education. Male students have a significantly higher working profile ($p<0.05$). These also have more knowledge about their family income ($p<0.001$). The family income of male students is significantly higher ($p<0.001$) compared to female students.

Table 1: Profile and sociodemographic characteristics of the participants.

Sociodemographic variables	Total	Sex		p*
	n (%)	Male (n = 571) n (%)	Female (n = 559) n (%)	
Age, Years***	16.6 (1.1)	16.6 (1.1)	16.5 (1.2)	**0.010****
Education				
1st Year	526 (46.5)	259 (45.4)	267 (47.8)	0.715
2nd grade	344 (30.4)	177 (31.0)	167 (29.9)	
3rd grade	260 (23.0)	135 (23.6)	125 (22.4)	
Are you working?				
I don't work	907 (80.3)	436 (76.4)	471 (84.3)	0.001
I am doing an internship	55 (4.9)	27 (4.7)	28 (5.0)	
I work with a salary	98 (8.7)	67 (11.7)	31 (5.5)	
I work without a salary	70 (6.2)	41 (7.2)	29 (5.2)	
Family income				
Don't know	529 (46.8)	250 (43.8)	279 (49.9)	<0.001
Less than 1 SM	152 (13.5)	58 (10.2)	94 (16.8)	
Between 1 and 3 MW	390 (34.5)	223 (39.1)	167 (29.9)	
Between 3 and 5 MW	59 (5.2)	40 (7.0)	19 (3.4)	

Values expressed in n (%). *Chi-square test. **Student's t-test. ***Values expressed as mean and standard deviation. In bold, considered significant p<0.05 and highly significant for p<0.001. Legends (SM = minimum wage).

For the analysis, the Statistical Package for the Social Sciences (SPSS) version 23 was used. Quantitative variables were expressed as mean and standard deviation. For the association analyses the chi-square test or the student t-test was used. It was considered significant p<0.05 and highly significant p<0.001.

Sleepiness during and after school was organized as independent variables and the aspects: of use, dependence, and sleep deprivation on the internet; relationships, and complaints associated with internet use, were organized as dependent variables.

For analysis and understanding of the data collected, the records were grouped, reducing the number of answers generated for each question, and favoring the crossing of data in the relationship tests between the variables. For all the variables analyzed, for the response items "Never, Rarely, and Sometimes" the participants were classified as not exposed to risk, and for the response items "Almost Always and Always" the participants were classified as exposed to risk.

This study complied with all the ethical precepts of research involving human subjects. The students were invited to participate voluntarily. The Informed Consent Form (ICF) was applied to the guardians of students under 18 years of age and the Term of Consent. The Term of Consent was presented and signed by the principals of the schools that comprised the research setting. The study was approved by the Research Ethics Committee of the Inta University Center - UNINTA, process #3.706.537.

RESULTS

From the students' reports detailed in Table 2, we have that the largest portion of students (93%) is not exposed to the risk of sleepiness during classes. For technology use, 59.3% use excessively, 39.9% have a sense of dependence, 32.6% report sleep deprivation, 26.7% have a failure when trying to decrease internet use, 25.7% have relationships created from the internet, and 39.1% receive constant complaints from others about their internet use. In the students in the group exposed to the risk of sleepiness during class, in all the intersections where the relationship gave significance (p<0.05), the largest portion of the students are also exposed to the risk of using technologies. The largest portion of the students who are not exposed to the risk of feeling addicted, sleep deprivation, and complaining to others about internet use, are also not exposed to the risk of sleepiness during class (p<0.05).

From the student reports detailed in Table 3, the prevalence of sleepiness after class is 31.68%, up considerably from the prevalence found in sleepiness during the class of 7%. The largest portion of students exposed to the risk of after-school sleepiness uses the Internet excessively (p<0.001). However, still referring to the students who reported feeling sleepy after class, we have that: for the feeling of dependence, sleep deprivation due to excessive use, failure when trying to reduce use, and complaints from classmates about internet use, the situation is reversed with the largest portion of students not being exposed to these risks (p<0.05).

The group of students not exposed to the risk of sleepiness after school had their largest portion also not exposed to the risk of feeling addicted, sleep deprivation, or failure when trying to decrease complaints from others about internet use (p<0.05). The adolescents' relationship with internet use is classified here as complex.

Table 2: Comparisons between technology use and sleepiness during classes in adolescents

Variables	Total	Sleepiness during classes		p*
	n (%)	Not exposed (n=1051 - 93%) n (%)	Exposed (n =79 – 7%) n (%)	
Excessive internet use				
Not Exposed	460 (40.7)	447 (42.5)	13 (16.5)	<0.001
Exposed	670 (59.3)	604 (57.5)	66 (83.5)	
The feeling of dependency on internet use				
Not Exposed	679 (60.1)	646 (61.5)	33 (41.8)	0.001
Exposed	451 (39.9)	405 (38.5)	46 (58.2)	
Sleep deprivation due to excessive internet use				
Not Exposed	762 (67.4)	730 (69.5)	32 (40.5)	<0.001
Exposed	368 (32.6)	321 (30.5)	47 (59.5)	
Unsuccessful attempts to cut down on internet use				
Not Exposed	828 (73.3)	776 (73.8)	52 (65.8)	0.121
Exposed	303 (26.7)	275 (26.2)	27 (34.2)	
Relationships created from internet use				
Not Exposed	840 (74.3)	784 (74.6)	56 (70.9)	0.467
Exposed	290 (25.7)	267 (25.4)	23 (29.1)	
Complaints from other people about your internet use				
Not Exposed	688 (60.9)	653 (61.2)	35 (44.3)	0.002
Exposed	442 (39.1)	398 (37.9)	44 (55.7)	

Values expressed in n (%). *Chi-square test. In bold, considered significant p<0.05 and highly significant p<0.001.

Table 3: Comparisons between technology use and after-school sleepiness in adolescents

Variables	Total	Sleepiness after school		p*
	n (%)	Not exposed (n=772 - 68.32%) n (%)	Exposed (n=358 - 31.68%) n (5)	
Excessive internet use				
Not Exposed	460 (40.7)	345 (44.7)	115 (32.1)	<0.001
Exposed	670 (59.3)	427 (55.3)	243 (67.9)	
The feeling of dependency on internet use				
Not Exposed	679 (60.1)	496 (64.2)	183 (51.1)	<0.001
Exposed	451 (39.9)	276 (35.8)	175 (48.9)	
Sleep deprivation due to excessive internet use				
Not Exposed	752 (67.4)	538 (69.7)	224 (62.6)	0.018
Exposed	368 (32.6)	234 (30.3)	134 (37.4)	
Unsuccessful attempts to cut down on internet use				
Not Exposed	828 (73.3)	586 (75.9)	242 (67.6)	0.003
Exposed	302 (26.7)	186 (24.1)	116 (32.4)	
Relationships created from internet use				
Not Exposed	840 (74.3)	587 (76.0)	253 (70.7)	0.055
Exposed	290 (25.7)	185 (24.0)	105 (29.3)	
Complaints from other people about your internet use				
Not Exposed	688 (60.9)	488 (63.2)	200 (55.9)	0.019
Exposed	442 (39.1)	284 (36.8)	158 (44.1)	

Values expressed in n (%). *Chi-square test. In bold, considered significant p<0.05 and highly significant p<0.001.

DISCUSSION

With technological advances, HTs or smartphones have become a reality in the lives of students. Although it is a tool that enhances access to information, the use of this equipment inappropriately can bring negative consequences to the user's health[13]. The use of smartphones is related to rewarding behaviors and can condition the user's brain to stay connected to the device for an excessive amount of time, distancing him from his essential activities. Adolescents, who in turn are in a state of physical and social maturation, become more exposed to the risk of addiction.[7,14]

Addiction can generate a cascade effect with several factors that aggravate the adolescent's health, among which we highlight the impact on the duration and quality of sleep, these being the two most commonly used indicators to reflect the status of sleep in related studies[7,15]. It is important to note that the main cause of EDS is sleep deprivation, thus this has also been considered a marker of sleep quality, especially in large-scale research or epidemiological studies[16].

Hong et al.[17] conducted a study of 1,721 school students in Beijing and Hunan provinces in China with an age range of 11 to 17 years. As a result, it was found that mobile phone addiction is associated with cognitive failures in daily life and sleep quality (but not duration). Adolescents who are addicted or have more interaction with their CTs are more likely to be passively awakened after falling asleep. Thus, it is important to support that excessive digital technology use has been indirectly associated with decreased cognitive performance through the mediating role of sleep status.

In the study by Jenkins et al.[18] conducted with 5,529 adolescents from secondary schools in London and the UK, the relationship between social media use and quality of life was assessed. The study found that two-thirds of the participants used social media. Use of these social networks on weekdays and weekends via MP and other devices was significantly associated with lower quality of life in females, but not in males.

CT use in the evening was also significantly associated with quality of life in women, considering the adjusted beta coefficient of 2.20 (95% CI - 3.18, - 1.22). Greater use of social media was associated with greater behavioral difficulties in all genders (p-value for trend <0.001). Similarly, these media were also associated with greater behavioral difficulties, adjusted beta coefficient of 2.54 (95% CI 2.09, 2.98). The study classifies adolescents' relationship with information technology as complex and recommends further research to better understand this social phenomenon.

In a survey that evaluated sleep quality and academic performance, Adelantado-Renau et al.[19] on 269 adolescents with an average age of 14 years in schools in Spain. Sleep quality (but not sleep duration) was associated with all indicators of academic performance. Analysis of covariance showed higher scores among students with better sleep quality. These analyses showed no differences in cognitive performance. Internet usage time was revealed to be a mediator of the association between sleep quality and academic performance, being significant for all indicators of academic performance (MP ranging from 15.5% to 16.0%). The study concludes that the association between sleep quality and academic performance in adolescents is mediated by Internet usage time. Thus, reducing the time internet use occasionally should improve the sleep quality of youth, generating potentially positive effects on academic performance.

Matos et al.[20] investigated the use of technologies by young students in Portugal. Participants in the study were 8,215 adolescents with a mean age of 14.36 years (SD=2.28). As result, regarding the use of technology, 62% of young people report that they talk several times a day online with their closest friends. The five measures of relationship with the internet (contact; intimacy; screen time; conflicts and dependence) always show significant correlations with each other, with the highest correlation identified between screen time and conflicts from excessive internet use (r=0.365) and the correlation identified between screen time and contacts with others online (r=0.329), followed by the correlation between social media dependence and intimacy (r=0.262) and the relationship between social media dependence and contact with others online (r=0.215). The largest portion of students report not feeling comfortable talking about their personal feelings, thoughts, and concerns, however, more than 20% of adolescents report having an easier time talking about themselves online.

In a previous study, Moreira et al.[21] evaluated the quality of sleep and sleepiness in 164 students (16-19 years old) in two public schools in the municipality of Itararé, São Paulo. They observed that 69.9% of the students had sleep complaints. This was similar to the data presented. The study characterizes as worrisome the prevalence and alteration in sleep patterns in high school students. The percentage values described are similar to the evidence of the present study.

Including the use of the internet as a mediator in the analysis of sleep studies are fundamental to considering the consequences of the contemporary context on the quality of life of individuals. A study by Santos et al.[22] investigated the sleep and napping habits of Brazilian adolescents, showing serious sleep restrictions, where only 27.6% of the sample met the sleep recommendations and 58.1% had the habit of napping. Frequent and prolonged naps can have detrimental effects on nighttime sleep, and the research also showed an association between sleepiness and poor sleep quality with an increase in the number of daytime naps.

In contrast, the study by Souza et al.[23] was conducted with 466 adolescents (15 to 17 years old) in a military school in the city of Fortaleza, Ceará, Brazil. It was identified that 60% of the adolescents had low weekly sleep duration. In the final regression model, we observed a higher risk of EDS in individuals with low sleep duration (OR: 1.55; 95% CI: 1.04-2.31) and who used a cell phone before bed (OR: 4.30; 95% CI: 2.00-9.23).

During adolescence, it is important to highlight some changes in the sleep-wake cycle, which add a delay in the sleep phase, characterized by later bedtimes and later awakenings. This delay tends to be a product of increased nocturnal social interaction and is in contrast to the start times of classes in the morning, favoring a reduction in the student's hours of sleep. Another aspect to be considered is the possibility that with the advance of the adolescent period, young people start to determine their sleep schedules[24].

The EDS is the direct consequence of sleep deprivation or insufficient sleep syndrome and can affect cognitive ability such as reduced attention, memory consolidation, and learning, thus implying compromised academic performance at school[20]. The behavioral risk factors, including irregular sleep habits, begin in adolescence and may extend into adulthood. It is in this context that the use of electronic devices has been increasing among adolescents, especially before they go to sleep, thus aggravating the problem of short periods of sleep[25].

It is important to consider that technological innovations represent a recently included component in the life context of both adolescents and adults. Thus, young people currently experience a technological reality that is different from that of their parents, who do not follow the use of these technologies in which they have access to diverse information in real time[26].

The behavioral variables have their base installed in the family context and the difficulty of parents to engage in the virtual literacy of their children contributes to the risky behaviors in social networks (excessive use and personal exposure)[27].

Thus, the school assumes a relevant role as an educational institution and must consider the advances and access to technology in the lives of students and its developments so that the educational practices refer to the need for preventive measures.

Regarding this issue, it is up to the teachers and the school community to plan and apply pedagogical measures that contribute to the clarification of young people on the conscious use of information technology. Thus, it is expected that the student will enjoy the numerous benefits that technological advances have to offer and distance himself from the harm inherent to dependence on them[28].

From the unfolding of students' relationship with new information technologies and the state of SED, we have highlighted that: the markers of adolescents' use of technologies were high so that 59.3% report excessive use, 39.9% have a feeling of dependence, 32.6% report sleep deprivation as a result of excessive internet use, 26.7% have a failure when trying to decrease internet use, 25.7%.

The meaningful relationship found between the state of SED and the excessive use of technologies/internet among adolescent students also stands out here. The relationships between the variables presented in this study allow us to conclude that the more the young school student uses Internet access equipment, the more he/she is exposed to the risk of sleep adversities. The study classifies the relationship of adolescents with information technology as complex and recommends further research to better understand this social phenomenon.

We also conclude that the dependence on the use of devices with Internet access, in its various forms, is a reality among young students, which makes it essential, given the current generation, that traditional classes make room for the insertion of pedagogical technologies, which, besides enhancing the learning of content, favor the understanding and criticality of young people about the limits and dependence associated with the constant use of equipment connected to networks.

The school must consider this context, understand the need for interventions in the educational sphere, conducting health education practices that direct students to better habits regarding the aspects that impact sleep health.

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