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| RESEARCH ARTICLE

Incidence of Smartphone Addiction, Poor Sleep Quality and Daytime Sleepiness on Academic Performance of High School Students in Marrakech

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| ABSTRACT

Excessive use of smartphones has been associated with both poor sleep quality as well as daytime sleepiness. In the educational context, it is established that these factors often have an impact on the academic performance of students. This cross-sectional study is conducted to assess the impact of sleep quality in relation to the use of smartphones on academic performance among Moroccan high school students in the city of Marrakech. It involves 570 students of both sexes, aged 17 to 20 years. Participants answered a self-administered questionnaire assessing Smartphone Addiction (SA), Sleep Quality (SQ), and excessive Daytime Sleepiness (DS). The results show that smartphone addiction is positively correlated with poor sleep quality ($r = 0.445$; $p = 0.000$) and daytime sleepiness ($r = 0.482$; $p = 0.000$). In the same vein, academic performance is negatively correlated with smartphone addiction ($r = -.144$; $p < 0.05$), poor sleep quality ($r = -0.074$, $p > 0.05$), and daytime sleepiness ($r = -0.073$, $p > 0.05$). Smartphone addiction has proven to have a negative impact on sleep quality, daytime sleepiness, and academic performance of high school students. These results call on parents and school health officials to implement awareness campaigns aimed at promoting rational and moderate use of screens and healthy sleep among high school students.

| KEYWORDS

Smartphone Addiction, High School Students, Sleep Quality, Daytime Sleepiness.

| ARTICLE INFORMATION

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1. Introduction

Adolescents currently live in a social context characterized by the phenomenal expansion of the Internet and smartphones. In 2023, the number of Internet users globally reached 5.19 billion, while social media users totaled 4.88 billion (We are Social, 2023). In Morocco, the Internet penetration rate increased from 5.9% in 2010 to 106.8% in the third quarter of 2023 (Statista, 2024). According to the Moroccan National telecommunication Regulation Agency (ANRT), mobile phone equipment reached 94.2% among young people aged 12 to 14 and 98.9% among 15–18-year-olds (ANRT, 2023).

1.1 Sleep and Education

In the field of education, it is established that good sleep promotes general well-being, helps to stay focused, think creatively, and solve problems. Poor quality sleep often negatively impacts overall cognitive abilities, alertness, attention, memory, and academic performance (De Bruin et al., 2017; Khan & Al-Jahdali, 2023; Nelabhotla & Shanmugam, 2021). In fact, in a longitudinal study, De Bruin et al. (2017) found that following 7 nights of sleep restriction (only 5 hours per night), adolescents had a progressive deterioration in sustained attention, memory work, and executive function, increased daytime sleepiness, and decreased positive mood.

1.2 Smartphones in Adolescents' Lives

Today, smartphones are essential tools in the daily life of most adolescents. Using one of these rationally is positive as it allows one to stay in touch with parents, friends, and teachers. It offers instant access to the Internet to carry out research, acquire new knowledge, and open up to new horizons. However, most students have difficulty regulating the use of their smartphones, and some can no longer imagine life without a smartphone (Vaterlaus et al., 2021). This, of course, comes with a cost: Spending too much time on screens can lead to smartphone addiction (SA) and lack of sleep. Numerous studies have linked problematic smartphone use to sleep problems, daytime sleepiness, and poor academic performance (Loleska & Pop-Jordanova, 2021; Tamura et al., 2017). In a 2019 study, Schaeffer revealed that 70% of adolescents often check their notifications or messages once they wake up, while more than half have Nomophobia (fear of being without one's phone) and associate the absence of their device with strong emotions such as sadness, loneliness, and anxiety. The researcher found that almost half of teens do not place much importance on the time they spend on their screens; only 54% were concerned about the overuse (Schaeffer, 2019).

1.3 Smartphone Addiction and Sleep Quality

Excessive use of screens (smartphones, computers, and tablets) can lead to Smartphone Addiction (SA). Researchers associate frequent use of mobile phones with smartphone addiction (SA) (Bhanderi et al., 2021; Derevensky et al., 2019; Kopecký et al., 2021; Méndez et al., 2024; Sadiq et al., 2022). Smartphone addiction is a type of behavioral addiction, much like Internet addiction. The two addictions are connected due to the similar symptoms they exhibit and the harmful effects they have on individuals. Smartphone addiction is classified as an impulse control disorder, which is marked by excessive and compulsive use of the device (Goldberg, 1996; Young, 1998).

Smartphone addiction is linked to a critical aspect of well-being: sleep. Sleep is a fundamental need, particularly during adolescence, a time of growth that includes important transformations in the brain, learning, supporting emotion, and cognition. During adolescence, sleep loss occurs due to behaviors that characterize this stage, including improved emotion regulation and heightened social cognition (Galván, 2020). Studies link poor sleep quality to smartphone addiction (Newton & Poluan, 2022; Richardson et al., 2021; van den Eijnden et al., 2021). Nocturnal activities on the smartphone can encroach on sleep time and disrupt the biological rhythm of sleep. In turn, insufficient sleep can lead to daytime sleepiness, affecting alertness the next day. SA is also associated with daytime sleepiness (DS) (Chung et al., 2018; Uzunçakmak et al., 2022).

1.4 Sleep and Academic Performance

Research in educational psychology highlights the key role of sleep and physical activity on cognitive and academic performance (Mazza et al., 2022). Recent studies suggest that sleep disturbances during adolescence negatively affect physical health, mental health, and academic performance. (Duncan et al., 2022). The World Health Organization (WHO) describes adolescence as a stage of development that occurs between the ages of 10 and 19 (WHO, 2024). This period is characterized by physiological and emotional changes that affect behavior and sleep. Adolescents need 8 to 10 hours of sleep per night to perform daily activities optimally. However, according to the WHO, young people sleep on average 7 hours 13 minutes per night. In addition, another recent study by the Vinci Foundation and the National Federation of Parents and Educators (FNEPE) suggests that 43% of young people aged 12-18 sleep less than 7 hours per night and 35% suffer from daytime sleepiness (CP-Fondation-VINCI-A, 2023).

1.5 Daytime Sleepiness among Adolescents

Daytime sleepiness is one of the common symptoms that any healthy person can experience, especially at nap time or following exceptional circumstances that can occur from time to time or rarely (Examples: spending a sleepless night during an event: health problem, long-distance night travel, etc.). There is also excessive daytime sleepiness. This type can be associated with pathologies that fall within the clinical domain but also with lack of sleep and/or poor quality of sleep. Excessive daytime sleepiness often leads to difficulties in daily life and sometimes even fatal accidents. In this study, we focused on excessive nocturnal sleep deprivation, which may lead to a strong need to sleep during the day due to sleep debt related to excessive smartphone use. Daytime sleepiness is a frequent occurrence among adolescents. In this specific group, experiencing daytime sleepiness is linked to challenges in social interactions with friends or family. (Hein et al., 2020). In the educational context, daytime sleepiness is an indicator of lack of attention and concentration; if persistent, it becomes a predictor of low performance and poor academic results (Alfonsi et al., 2020; Li et al., 2024). Our research examines daytime sleepiness, which is characterized by a greater likelihood of falling asleep. This phenomenon can happen during moments and in circumstances when a person is expected to remain awake and alert. (Bruni, 2023).

Daytime sleepiness in adolescents can be explained by various internal (biological and psychological) and external factors (academic demands use of digital devices). Additionally, daytime sleepiness increases significantly in adolescents with SA (Çağan & Koca, 2020; Chung et al., 2018; Gundogdu et al., 2021; Malheiros et al., 2021; Rachubińska et al., 2023). We are particularly interested in daytime sleepiness linked to the disturbance of the circadian rhythm due to the use of screens; this biological process

regulating the sleep-wake cycle can be influenced by artificial light from screens (Blume et al., 2019) and irregular sleep (Sun & Chen, 2022). While Insomnia is characterized by the difficulty in falling asleep or remaining asleep, waking up early in the morning, or feeling the need to sleep again, excessive daytime sleepiness refers to the inclination to doze off during the day, even when one is expected to remain awake (MSD Manuel, 2022).

Our study aims to investigate the interrelationship between smartphone addiction, sleep quality, and daytime sleepiness. Furthermore, this investigation will analyze the degree to which smartphone addiction predicts reduced sleep quality and heightened daytime sleepiness in the targeted population.

2. Methods

This research uses a cross-sectional design with the aim of exploring the potential connection between smartphone addiction sleep quality in addition to daytime sleepiness among high school students in Marrakech, Morocco. The sample of participants was selected through stratified random sampling, thus ensuring representation across different schools and socio-economic backgrounds. Data were collected using validated questionnaires, including the Smartphone Addiction Scale (SAS) together wit the Pittsburgh Sleep Quality Index (PSQI), alongside self-reported measures of daytime sleepiness. Statistical analyses, including correlation, were applied to assess the strength and nature of the relationships between the variables.

2.1 Study Objectives

There has been a dearth of research on sleep deprivation and daytime sleepiness in relation to smartphone addiction among high school students in Morocco. This study aims to fill this gap and identify the consequences of smartphone addiction among students in the Moroccan context sleepwise. Three questions guide this study:

1. Is there a prevalence of smartphone addiction that affects sleep and leads to daytime sleepiness among high school students?
2. Is there a significant correlation between mobile addiction, attitude, and objective of use among high school students?
3. What are the determining factors (gender, age) of the variance of smartphone addiction, poor sleep quality and daytime sleepiness among high school students?

In the quest for tangible answers, we formulate the following hypotheses:

H1: There is a prevalence of smartphone addiction, poor sleep quality as well as daytime sleepiness among Moroccan high school students.
H2: A positive correlation lies between smartphone usage, sleep quality, daytime sleepiness, and a negative correlation between these three variables and the academic performance of high school students.
H3: Smartphone addiction, poor sleep quality, and daytime sleepiness affect the academic performance of Moroccan high school students.

2.2 Study Design

A cross-sectional study was conducted among 570 public high school students in Marrakech. Their ages ranged from 17 to 20 years old and only students who owned smartphones were invited to voluntarily and willingly answer the survey online.

2.3 Instruments

For data collection, a four-part questionnaire was used; the first part focused on demographic characteristics, while the following sections addressed data relating to smartphone use, sleep quality, and daytime sleepiness, respectively.

2.3.1 Smartphone Addiction Scale-Short Version SAS-SV

Smartphone addiction was measured using SAS-SV. It is a ten-item instrument that assesses addiction to smartphones in adolescents (Kwon et al., 2013). Each item of the SAS-SV is scored using a six-point Likert scale, which ranges from 1 (strongly disagree) to 6 (completely agree), resulting in a possible total score between 10 and 60. A threshold of value of 31 was recommended for boys while that for girls is set at 33.

2.3.2 Pittsburgh Sleep Quality Index (PSQI)

The PSQI, or Pittsburgh Sleep Quality Index, is a questionnaire that individuals fill out to evaluate their sleep patterns over the past month. This scale consists of questions related to various aspects of sleep, including quality, latency, habitual efficiency, duration, use of sleeping pills, disturbances, and daytime dysfunction. The overall score ranges from 0 to 21, calculated by adding together component values that range from 0 to 3. A PSQI score that exceeds 5 suggests poor sleep, with higher scores indicating worse sleep quality.

2.3.3 Pediatric Daytime Sleepiness Scale (PDSS)

The Epworth Pediatric Day Sleepiness Scale (PDSS) is an 8-item questionnaire. It was developed and validated in 442 adolescents to assess daytime sleepiness and its impact on academic performance. A score > 26 corresponds to poor academic performance. The PDSS is often preferred due to its simple administration and strong psychometric qualities. Scores range from 0 to 32. The mean scores in the original study were 15.3 ± 6.2 (Drake et al., 2003). Higher scores indicate severe daytime sleepiness. The internal consistency of the scale, measured by Cronbach's alpha, was found to be 0.80. When this scale was adjusted for the Moroccan context and translated into Arabic, its internal consistency measured by Cronbach's alpha was close to the original version (0.75).

2.4 Data Analysis

We conducted a statistical analysis of our data using SPSS 26.0 for Windows software. Descriptive statistics were performed to report the analysis of data presented in terms of both median and standard deviation. Also, categorical variables were displayed as frequency and percentage. In addition, the Chi-square test was used to compare non-parametric variables between sexes. Categorical variables were compared between groups using the chi-square test. To assess the strength of the correlation between variables, Spearman correlations were applied. A value of less than 0.05 was deemed statistically significant.

3. Results

Table 1 presents the frequencies and percentages of the sociodemographic attributes of the 570 participants: 57.2% were female; 81.9% of respondents were between 15 and 17 years old; 30% were in the common core; 33% in the 1st year of the baccalaureate and 37% in the 2nd year.

Table 1: Sociodemographic characteristics

Characteristics		n (%)
Gender	Male	244 (42,8)
	Female	326 (57,2)
Age	15 – 17	467 (81,9)
	18 – 20	103 (18,1)
Grade school	Common Core	171 (30,0)
	1st Bac	188 (33,0)
	2nd Bac	211 (37,0)
Academic. Performance	Modest	346 (60.7)
	Honorable	224 (39.3)

H1: There is a prevalence of daytime sleepiness, poor sleep quality as well as smartphone addiction in high school students.

The means of the SAS_SV, PSQI, and PDSS scores (table 2) are higher than the risk thresholds proposed for them by the developer of SAS-SV; the median 33 is higher than the threshold 31 for males, and it is equal to the threshold 33 for females (Kwon et al., 2013). The median 7 of PSQI is higher than the risk threshold (Buysse et al., 1989). The mean 16 of PDSS is higher than the threshold 15. This indicates that smartphone addiction, inadequate sleep quality, together with daytime sleepiness are common among high school students. Consequently, H1 is validated.

Table 2: Descriptive Statistics for (SAS-SV), (PSQI), and (PDSS) Scores

Scores	Median	Std. Deviation
SAS_SV	33.00	11.039
PSQI	7.00	3.065
PDSS	16.00	6.358

H2: A positive correlation exists between smartphone usage, sleep quality, daytime sleepiness. Also, these three factors are negatively correlated to the academic performance of high school students.

3.1 Correlation between (SAS-SV), (PSQI) and (PDSS)

A significant positive correlation exists between the (SAS_SV) and (PSQI) variables ($r = 0.353$; $p < 0.05$) (Table 3). This means that when smartphone addiction increases or decreases, poor sleep quality also increases or decreases (see Figure 1).

A strong positive correlation exists between the (SAS_SV) and (PDSS) variables ($r = 0.482$; $p < 0.05$). This means that when smartphone addiction increases or decreases, daytime sleepiness also increases or decreases (see Figure 2).

In the same vein, a significant positive correlation exists between the PSQI and PDSS variables (r = 0.445; p < 0.05). This means that when smartphone addiction increases or decreases, daytime sleepiness also increases or decreases (see Figure 3).

Table 3: Correlation between SAS-SV, PSQI and PDSS

Correlations				
			PSQI	PDSS
Spearman's rho	SAS_SV	Correlation Coefficient	,353**	,482**
	PSQI	Correlation Coefficient	.	,445**

**. Correlation is significant at the 0.01 level (2-tailed).

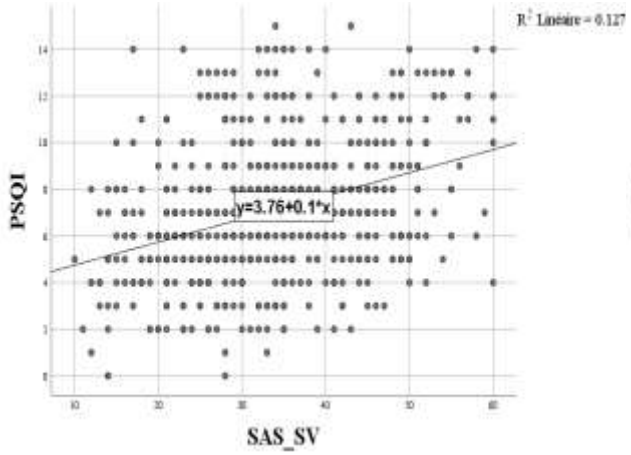

Figure 1: Correlation SAS-SV – PSQI

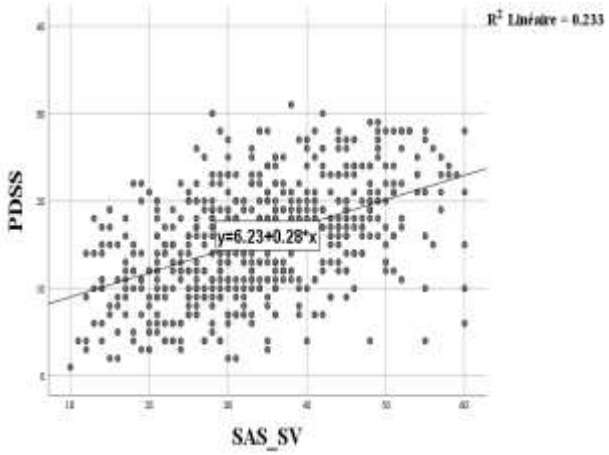

Figure 2: Correlation SAS-SV -PDSS

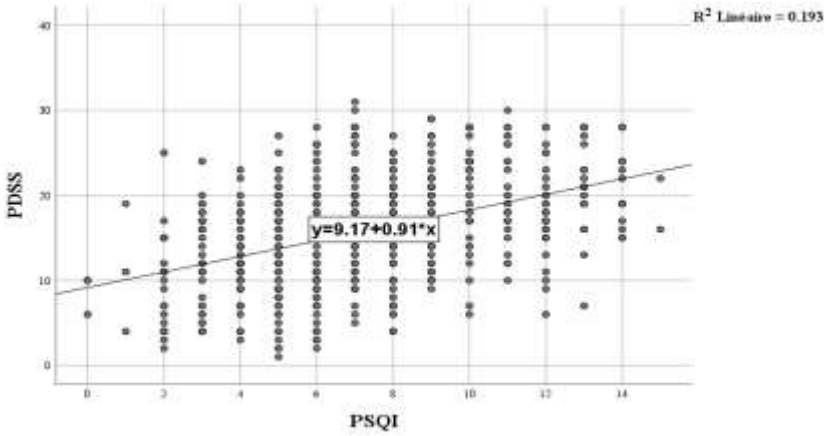

Figure 3: Correlation between PSQI - PQSS

3.2 Correlation between Academic Performance, (SAS-SV), (PSQI), and (PDSS)

There is a negative correlation between the Academic Performance variable and the three (SAS_SV), (PSQI), and (PDSS) other variables. Only correlation with the SAS_SV variable is significant (r = -.144; p = 0.001) because the p-value of the other two is higher than 0.05 (table 4). Figures 1, 2, and 3 corroborate these findings.

Table 4 : Academic Performance *SAS_SV * PSQI * PSDD Correlations

			SAS_SV	PSQI scores	PDSS
Spearman's rho	Academic Performance	Correlation Coefficient	-.144-	-.074-	-.073-
		Sig. (2-tailed)	.001	.078	.081

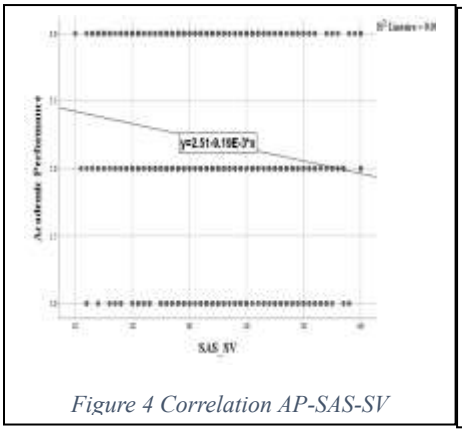

Figure 4 Correlation AP-SAS-SV

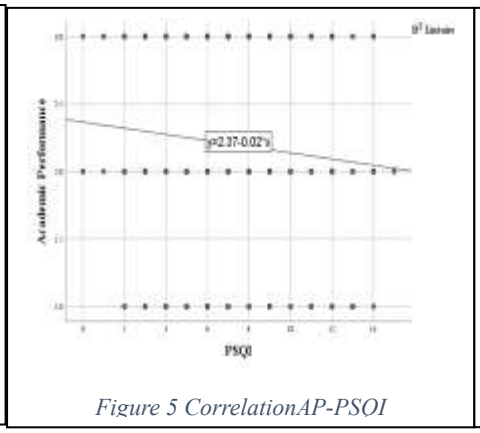

Figure 5 CorrelationAP-PSQI

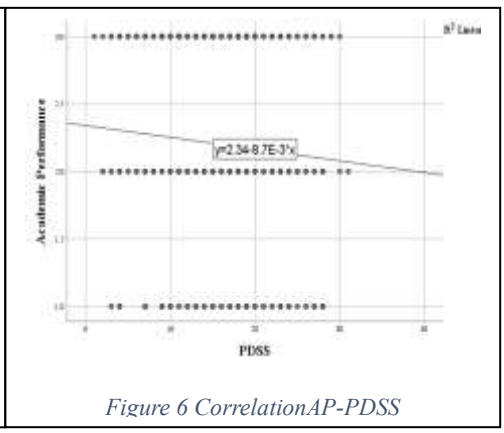

Figure 6 CorrelationAP-PDSS

H 3: The prevalence of SA, SQ, and DS is the same in both gender categories

H0: The prevalence of SA, SQ, and DS is not the same in the two gender categories

The results of the chi-square test of independence (table 1) indicate that:

3.2.1 Smartphone Addiction Variable:

An association exists between the Smartphone Addiction variable and the Gender variables (p = 0.011). This means that smartphone addiction depends on being male or female. This is corroborated by the Bonferroni adjustments (table 2): The percentage of SAs in the Male group is higher than that of No SAs. On the other hand, the percentage of No SAs in the Female group is greater than the percentage of SAs. Therefore, H0 is rejected in favor of H1.

3.2.2 Sleep Quality Variable

The Sleep Quality variable is dependent on the Gender variable (p = 0.000). To put it another way, there is a notable link between the quality of sleep and the gender of high school students. This is corroborated by the Bonferroni adjustments (table 2): The percentage of individuals classified as Worse in the Female group is higher than that of those classified as Better; conversely, the proportion of the category Better in the Male group is greater than the proportion of the Worse group. H0 is therefore rejected in favor of H1.

3.2.3 Daytime sleepiness Variable

The Daytime sleepiness variable is dependent on the Gender variable (p = 0.007). In other words, there is a significant association between sleep quality and gender of high school students. This is corroborated by the Bonferroni adjustments (table 2): the proportion of DS risks in the Female group is greater than that of No DS risks; conversely, the proportion of No DS risk in the Male group is greater than the proportion of DS risk. H0 is therefore rejected in favor of H1.

Table 5: Chi-square test of independence

		Gender		Total
		Male N (%)	Female N (%)	N (%)
Smartphone Addiction	No SA	93 (38.1)	159 (48.8)	252 (44.2)
	SA	151 (61.9)	167 (51.2)	318 (55.8)
X^2 (p)		.011*		
Sleep Quality	Better	102 (41.8)	88 (27.0)	190 (33.3)
	Worse	142 (58.2)	238 (73.0)	380 (66.7)
X^2 (p)		.000*		
Daytime sleepiness	No DS risk	146 (59.8)	158 (48.5)	304 (53.3)
	DS risk	98 (40.2)	168 (51.5)	266 (46.7)
		.007		

. The Chi-square statistic is significant at the .05 level.

Table 6 Bonferroni test: Comparisons of Column Proportions

		Gender	
		Male	Female
		(A)	(B)
Smartphone Addiction	No SA		A(.011)
	SA	B(.011)	
Sleep Quality	Better	B(.000)	
	Worse		A(.000)
Daytime Sleepiness	No DS risk	B(.007)	
	DS risk		A(.007)

The results are derived from two-sided tests. In each major pair, the key for the category with the smaller column proportion is shown in the category with the larger column proportion.
Significance level for uppercase letters (A, B, C)is set at .05

4. Discussion

The findings from the statistical analysis in this study indicate a notable occurrence of smartphone addiction, which stands at 55.8%. Besides, the study emphasizes that 66.7% of public high school students in Marrakech experience poor sleep quality, and 46.7% of the students report experiencing daytime sleepiness. Given these results, we can say that these students depend much on their smartphones during this pivotal stage between childhood and adulthood. For them, the smartphone is the tool that offers instant access to the Internet, a more welcoming and open space that allows them to build personal and social identity. On the web, they communicate freely, meet and share. They spend more and more time on their screens at the expense of rest and sleep. They love videos, movies, games, and social networks.

Our research shows that a positive correlation lies between excessive smartphone use, insufficient sleep, and feeling sleepy during the day. This demonstrates a high frequency of daytime sleepiness in high school students with poor sleep quality compared to those with normal sleep. Although many speeches and studies emphasize the dangers linked to screens, the smartphone has become an essential means of entertainment and socialization for young people.

Due to the impact of inadequate sleep on one's well-being as well as academic performance, the important question is how to make sure that screen use remains sustainable while avoiding potential risks. Smartphones have become critical in the everyday lives of young people. It would be unrealistic to think that they can be completely deprived of these devices. The challenge is how to guide them in their practice for reasonable use, which constitutes an opportunity to learn better, build a positive identity, and develop good social relationships.

4.1 Prevention Measures:

Daytime sleepiness may be a predictor of serious disorders such as depression, anxiety, and difficulty concentrating; in the educational field, daytime sleepiness is associated with passivity in class, low alertness, and reduced academic performance (Drake et al., 2003). Preventing daytime sleepiness resulting from inadequate sleep involves benefiting from optimal sleep duration (7 to 9 hours/night). To do this, it is recommended to:

- Reset the biological clock: go to bed and get up early, at set times every day.
- Avoid stimulants before sleeping: alcohol, caffeine, light and screens.
- Dine lightly (no fatty dishes).

4.2 Comparison with other studies

In Japan, 50.8% of adolescents, both males and females, have been addicted to smartphones (Tateno et al., 2019). In Saudi Arabia, 67.0% of students were found to be addicted to smartphones (Alotaibi et al., 2022). In Portugal, 86.3% of adolescents indicated that they had trouble waking up in the morning, while 59.7% expressed that they did not sleep well (de Sá et al., 2023).

4.3 Study Implications

The results of our study suggest that rapid identification and treatment of screen addiction and sleep deprivation could pave the way for preventing daytime sleepiness in adolescents. Specifically, controlling circadian rhythms can help lower the likelihood of experiencing daytime disorders and depression. Recent research indicates that cognitive behavioral therapy may be effective in addressing sleep issues and mitigating their impacts (Chen et al., 2021). A primary goal of the cognitive-behavioral method is to assist the individual in recognizing their emotions, sensations, thoughts, and actions, and the connections among these four components. This can help them identify the thoughts at the origin of their behavior and then modify them in order to react appropriately to what goes on in their surrounding environment and act more responsibly towards it (DiGiuseppe et al., 2017; Dozois et al., 2019; Keegan & Holas, 2010).

4.4 Limitations

Despite the study's contribution to the growing body of knowledge on the topic, particularly in an area where such studies are lacking, there are a few limitations to consider. On the one hand, the study's dependence on self-reported data may lead to biases; in fact, participants may be under the social desirability influence, whereby they may underreport or overestimate their sleep quality or daytime sleepiness so as to provide socially acceptable answers. On the other hand, the study's cross-sectional design does not confirm a causal link between smartphone addiction and sleep-related results. While it does confirm correlations, it cannot identify whether other factors come into play in such results. Such factors as stress levels, eating habits, or extracurricular activities need to be investigated.

5. Conclusion

The present study confirms the relationship between smartphone addiction, lack of sleep, and daytime sleepiness among high school students. According to the results of our statistical analyses, 56.9% of Moroccan high school students - 17/20-year-olds - are dependent on their smartphones, 73.2% have low quality sleep, and 46.7% suffer from daytime sleepiness. Overuse of smartphones may cause sleep disruption in high school students due to reduced duration and exposure to blue light from screens. This can lead to daytime sleepiness, which in turn affects alertness and concentration during work.

The impact of digital technology is clearly seen in the high usage of smartphones among students. This excessive use can negatively affect their sleep quality, which in turn influences their alertness and performance. As a result, it is critical to promote the adoption of strategies that support the healthy use of smartphones. The effect of digital technology is apparent due to the major smartphone usage. This can lead to poor sleep quality and affect students' alertness and performance. Thus, it is critical to encourage the implementation of measures that advocate for the healthy use of smartphones.

Daytime sleepiness is observable during the day and can be used as an intervention lever to make students aware of making changes in their lifestyle habits and correcting their sleep rhythm. Smartphones are essential in the daily lives of young people. It is illusory to want to keep them away from them. The challenge is not to deprive them of smartphones but to guide them in their practice for reasonable use. When used well, smartphones are an opportunity for young people to build their individuality, develop their social relationships, and learn. Daytime sleepiness is observable during the day and can be used as a lever for intervention to raise awareness among students to make changes in their lifestyle habits and correct their sleep rhythm.

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