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Technoaddiction and insomnia in female secondary school students in Peru

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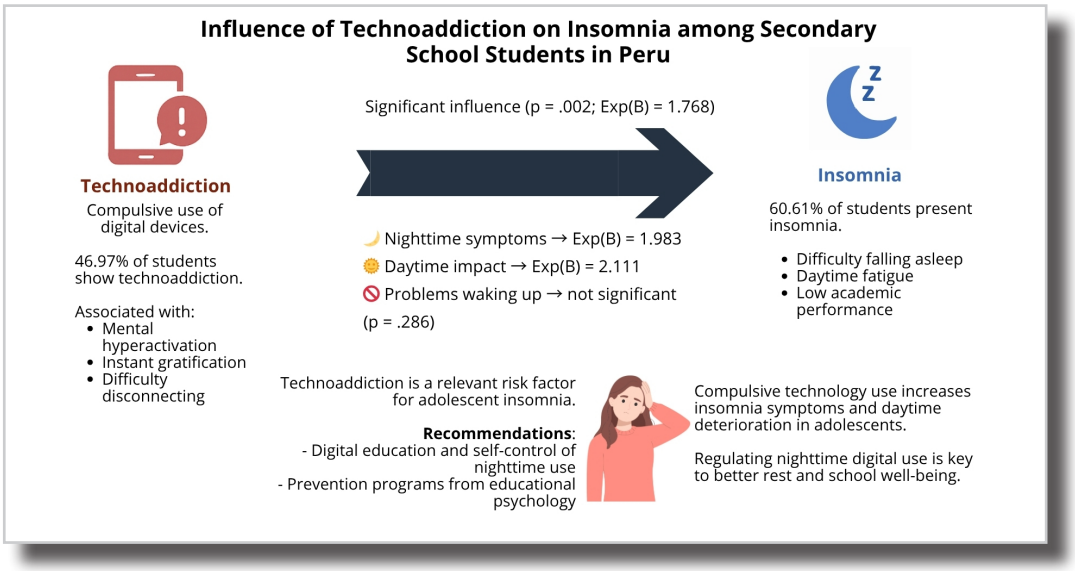
Highlights

- *The association between technoaddiction and insomnia was analyzed in 528 Peruvian female secondary school students.*
- *46.97% presented technoaddiction and 60.61% presented insomnia.*
- *Technoaddiction significantly increases the risk of overall insomnia.*
- *It primarily affects nocturnal symptoms and daytime impact, but not awakening problems.*
- *The findings support hyperarousal theory and instant gratification theory.*
- *Promoting self-regulation of nighttime technology use in school settings is recommended.*

Graphical Abstract



Abstract

Insomnia is an increasingly prevalent sleep disorder in adolescents, and is progressively associated with the intensive use of digital technologies. The objective of this study was to determine the influence of technoaddiction on insomnia in secondary school students in Peru. A non-experimental, cross-sectional, explanatory design was employed, with a sample of 528 female students aged 12 to 17 years from an educational institution in Tacna, Peru. Two validated instruments were administered: the Technoaddiction Scale and the Athens Insomnia Scale. The results showed that 46.97% of participants presented techno-addiction and 60.61% presented insomnia. Logistic regression analysis demonstrated that technoaddiction is significantly associated with overall insomnia ($p = 0.002$; $Exp(B) = 1.768$), nocturnal symptoms ($p < 0.001$; $Exp(B) = 1.983$), and daytime impact ($p < 0.001$; $Exp(B) = 2.111$), but not with awakening problems ($p = 0.286$). These findings support theories such as the hyperarousal theory and the instant gratification theory, which explain how compulsive use of technological devices affects sleep quality. It is concluded that technoaddiction constitutes an important risk factor for insomnia in adolescents, particularly regarding difficulties initiating sleep and deterioration of daytime functioning. The implementation of preventive strategies in the field of educational psychology is recommended, as well as school policies aimed at regulating technology use during nighttime hours.

Keywords: Technology Addiction. Adolescents. Insomnia. Digital Device Use. Internet Addiction Disorder.

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INTRODUCTION

In recent years, sleep disorders have become increasingly prevalent among adolescents, affecting their physical and emotional well-being as well as academic performance[1]. The constant use of digital technologies has modified lifestyles and rest habits; while facilitating communication and access to information, it increases the likelihood of developing technological dependency[2]. Prolonged use of electronic devices – particularly those connected to the internet – has altered the daily routines of young people, reducing the time devoted to sleep and compromising its quality[3]. This phenomenon has attracted the attention of the scientific community, which has raised concerns about the effects of nocturnal technological exposure on psychological equilibrium and academic performance[4].

International evidence converges in demonstrating that problematic technology use is associated with sleep disturbances in adolescents. Studies conducted across different contexts report associations between prolonged exposure to screens, social media, or video games and difficulties initiating sleep, nighttime awakenings, and reduced sleep quality[5,6]. Additionally, patterns of greater impairment in female adolescents have been described, along with associations with daytime fatigue, poorer academic performance, and comorbidity with anxiety in specific populations[7,8]. Although heterogeneous results exist regarding the strength of this association, the general trend indicates that technoaddiction and sleep problems represent a relevant public health phenomenon for adolescent health[9].

In the context of Latin America and Peru, this problem is also observed; however, evidence among secondary school students remains limited. In this country, a significant proportion of adolescents experience sleep difficulties associated with symptoms of stress and anxiety resulting from excessive use of electronic devices[10]. Furthermore, internet dependency and intensive use of social media are associated with poorer sleep quality and mental health[11,12,13]. Nevertheless, the majority of national studies have focused on adult or university populations, leaving this phenomenon largely unexplored among secondary school adolescents.

Technoaddiction is understood as a form of behavioral dependency characterized by excessive and uncontrolled use of digital media, interfering with psychological and social well-being[14,15], reinforced by dynamics of immediate reward (instant gratification theory)[16] and by socio-emotional needs (media dependency theory)[17]. Insomnia, in turn, is understood as a sleep disorder in which the individual is dissatisfied with the quantity or quality of sleep, compromising their daytime functioning[18], and is interpreted through the lens of the hyperarousal theory, according to which an increase in physiological and cognitive activation hinders the initiation and maintenance of sleep[19].

Based on the literature review, it was identified that dependency on screens (video games or mobile phones) continuously generates problems in rest habits[20,21]. However, its investigation remains limited in the Latin American context, where similar trends – such as nocturnal device use – affect sleep patterns with repercussions for mental health[10,22]. Therefore, there is a need to deepen the understanding of this problem in the school environment, where technology represents a fundamental resource in students' daily lives and learning processes. This study seeks to understand the relationship between technoaddiction and insomnia during adolescence among Peruvian female secondary school students.

METHODOLOGY

Sampling design

The type of research is descriptive, as it presents, narrates, describes, or identifies facts, situations, traits, and characteristics of the variables under study[23], with an explanatory-observational scope and a non-experimental design, given that the constructs analyzed were not manipulated or modified. It is likewise a cross-sectional study, as the data were collected at a specific time point[24].

Participants

The sample selected for the present study consisted of 528 students from an educational institution in Tacna, Peru, enrolled from the first to the fifth year of secondary education within the Regular Basic Education system, all female and aged between 12 and 17 years. Sample selection was non-probabilistic and by convenience, based on institutional access and compliance with ethical criteria (voluntary participation, assent, and informed consent).

The exclusive inclusion of female participants occurred because the participating institution has an exclusively female enrollment, and also with the intention of reducing heterogeneity attributable to sex differences in patterns of technology use and sleep. This decision limits the generalization of results to male populations.

All participants were informed of the study's objectives, and the confidentiality and anonymity of the collected data were guaranteed.

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Instruments

The instruments administered were the Technoaddiction Scale and the Athens Insomnia Scale (AIS).

The Technoaddiction Scale was developed to assess dependency on technological devices in adolescent and adult populations25. This instrument was adapted and validated for the Latin American context, presenting CFI = 0.971, TLI = 0.958, and RMSEA = 0.06626, along with internal consistency evidence of 0.845 according to Cronbach's alpha.

The Technoaddiction Scale comprises 8 items scored on a seven-option Likert scale ranging from "never" (0) to "always" (6). It is structured around two dimensions: a) excessive use, referring to the prolonged and disproportionate time devoted to technology; and b) compulsive use, associated with uncontrollable and repetitive behavior in which individuals feel an irresistible need to remain connected, even when aware of the negative consequences.

This scale is theoretically grounded in the instant gratification theory[16], which explains how immediate rewards obtained in digital environments reinforce compulsive technology use, and in the Media Dependency Theory[17], according to which individuals develop dependency on media according to their emotional, cognitive, and social needs. The responses were associated with experiences of using mobile phones, tablets, laptops, computers, or other devices (Table 1).

Regarding the Athens Insomnia Scale (AIS), its purpose is to measure insomnia in adolescents and adults[27]. This instrument was validated in the Latin American context, specifically in El Salvador[28], obtaining reliability of 0.88 for both Cronbach's alpha and McDonald's omega. The confirmatory factor analysis conducted during the adaptation demonstrated adequate construct validity, with satisfactory goodness-of-fit indices (CFI = 0.94; SRMR = 0.03; RMSEA = 0.10)[28].

The Athens Insomnia Scale comprises 8 items evaluated on a four-option Likert scale ranging from "no problem" (0) to "serious problem" (3). It is structured around three dimensions:

a) nocturnal symptoms, referring to difficulty initiating sleep or frequent nighttime awakenings;

b) awakening problems, representing difficulty getting up, prolonged drowsiness, and a sense of lethargy; and

c) daytime impact, consisting of persistent fatigue affecting the person's daily activities.

The theoretical framework of the AIS is related to the Hyperarousal Theory, which holds that insomnia arises from an elevated state of physiological and cognitive activation that interferes with the initiation and maintenance of sleep[18].

Procedures

Data collection was conducted in person in the classrooms and encompassed several stages during the months of September and October 2024. Initially, the necessary coordination and authorizations were obtained for conducting the research at the educational institution in September.

Subsequently, in-person information was provided to underage students regarding the study's objectives, while parents or legal guardians were informed in writing or by telephone, with the aim of obtaining informed consent and assent.

The scales were administered during October, using standardized instructions under the supervision of the research team, ensuring the anonymity and confidentiality of the participants.

Data analysis

In the present study, previously validated instruments were selected prior to data collection. Following confirmation of their reliability, these instruments were administered to the pre-defined sample.

The data obtained were organized and analyzed using an Excel 2021 spreadsheet and SPSS statistical software, version 26. Descriptive statistics (frequencies, mean, and standard deviation) were used to characterize the sample, as well as the main variables and their dimensions.

To test the main hypothesis, the normality of data residuals was estimated using the Kolmogorov-Smirnov test ($n > 50$). As this assumption was not met, different simple binary logistic regression models were applied.

The technoaddiction variable was considered the sole independent variable, while the dependent variables comprised: insomnia (without insomnia/with insomnia), nocturnal symptoms (with symptoms/without symptoms), awakening problems (with problems/without awakening problems), and daytime impact (with impact/without impact).

Furthermore, Odds Ratios (OR) with 95% confidence intervals were estimated. The significance level adopted was $\alpha = 0.05$ or 5%, enabling statistical decision-making.

Ethical considerations

The study considered ethical aspects throughout all stages of the research. Participant anonymity was maintained, and informed consent was obtained from parents prior to the study's implementation, given that the sample consisted of minors.

Furthermore, approval was obtained from the educational institution to ensure the scientific rigor of the work. The principle of non-maleficence was respected, ensuring that none of the activities conducted during the study caused physical or psychological harm to participants.

Likewise, participants were informed of the study's objectives, their rights as participants, and the confidentiality of the information provided.

RESULTS

Table 1 presents the characteristics of the participants. A relatively homogeneous distribution across school years is observed; the highest percentage corresponds to the first year of secondary school (20.83%) and the lowest to the fifth year (18.94%). The most commonly used device is the mobile phone (71.97%), followed by laptops (13.26%), while a minority use computers, tablets, or other devices.

Almost half of the participants use technological devices between 2 and 3 hours per day (49.81%) or between 4 and 5 hours (22.73%). Regarding rest hours, the majority report sleeping between 6 hours (26.14%) and 7 hours (31.44%) per night.

The mean age of participants was 14.56 years, with a standard deviation of 1.50.

Table 1 - Sociodemographic data of the study sample.

Variables	n	%
Year		
First	110	20.83
Second	109	20.64
Third	106	20.08
Fourth	103	19.51
Fifth	100	18.94
Most commonly used device		
Mobile phone	380	71.97
Laptop	70	13.26
Tablet	15	2.84
Desktop computer	50	9.47
Other	13	2.46
Daily device use time (hours)		
≤ 1 hour	41	7.77
2 to 3 hours	263	49.81
4 to 5 hours	120	22.73
≥ 6 hours	104	19.70
Daily hours of rest during the past week		
≤ 5 hours	120	22.73
6 hours	138	26.14
7 hours	166	31.44
≥ 8 hours	104	19.70
Age	μ = 14.56 years SD = 1.50	

Table 2 presents the levels of technoaddiction and its dimensions in the evaluated students. It is observed that 53.03% do not present technoaddiction, while 46.97% do. Regarding the dimensions, 43.94% exhibit excessive technology use and 56.06% do not display this behavior. Similarly, 63.64% Categories of insomnia and its dimensions. present compulsive use, in contrast to 36.36% who do not evidence such behavior.

Table 2 - Categories of technoaddiction and its dimensions.

Variables/Dimensions	Category	n	%
Technoaddiction	Without technoaddiction	280	53.03
	With technoaddiction	248	46.97
Excessive use	Without excessive use	296	56.06
	With excessive use	232	43.94
Compulsive use	Without compulsive use	192	36.36
	With compulsive use	336	63.64

Table 3 presents the levels of insomnia and its dimensions in the evaluated students. It is observed that 39.39% do not present insomnia, while 60.61% are affected by this disorder.

Regarding the dimensions, 40.91% exhibit nocturnal symptoms and 59.09% do not; 37.88% report awakening difficulties, in contrast to 62.12% who do not experience such difficulties; and 48.48% show daytime impact, while 51.52% do not present impairment in this dimension.

Table 3 - Categories of insomnia and its dimensions.

Variables	Category	n	%
Insomnia	Without insomnia	208	39.39
	With insomnia	320	60.61
Nocturnal symptoms	Without nocturnal symptoms	216	40.91
	With nocturnal symptoms	312	59.09
Awakening problems	Without awakening problems	200	37.88
	With awakening problems	328	62.12
Daytime impact	Without daytime impact	256	48.48
	With daytime impact	272	51.52

Table 4 shows the relationship between technoaddiction and insomnia categories. It is observed that among students without technoaddiction, 54.29% present insomnia, which allows for the understanding that other factors are capable of affecting students' sleep; whereas among those with technoaddiction, this proportion increases to 67.74%.

Overall, 60.61% of the total participants present insomnia, evidencing a higher incidence of sleep disturbances among those who display technoaddictive behaviors.

Table 4 - Cross-tabulation of technoaddiction and insomnia categories.

Insomnia categories	Categories of techno-addiction					
	Without technoaddiction		Technoaddiction		Total	
	n	%	n	%	n	%
Without insomnia	127	45.71	80	32.26	208	39.39
With insomnia	152	54.29	168	67.74	320	60.61
Total	280	100.00	248	100.00	528	100.00

Table 5 shows that technoaddiction significantly increases the risk of presenting insomnia ($p = 0.002$; OR = 1.768), as well as the presence of nocturnal symptoms ($p < 0.001$; OR = 1.983) and daytime impact ($p < 0.001$; OR = 2.111). In contrast, its association with awakening problems was not significant ($p = 0.286$; OR = 1.212).

The positive B coefficients indicate that the presence of technoaddiction increases the probability of the analyzed outcome. The largest effect was observed for daytime impact, equivalent to an approximate 11% increase in relative probabilities compared to the reference group.

Table 5 - Influence of technoaddiction on insomnia and its dimensions.

		Insomnia	Nocturnal symptoms	Awakening problems	Daytime impact
Technoaddiction	p	0.002	0.000	0.286	0.000
	B	0.570	0.685	0.192	0.747
	OR	1.768	1.983	1.212	2.111
	Pseudo R^2	0.019	0.027	0.002	0.034
	Chi^{i2}	10.037	14.593	1.142	18.004
	n	528	528	528	528

DISCUSSION

The results demonstrate that technoaddiction is associated with insomnia in secondary school students, particularly in the dimensions of nocturnal symptoms and daytime impact, while the relationship with awakening difficulties did not reach statistical significance. This finding addresses the general objective of the study by demonstrating that excessive and compulsive use of technological devices interferes with sleep initiation and continuity, as well as with daytime performance and well-being.

The logistic regression model demonstrated that adolescents with higher levels of technoaddiction are 1.77 times more likely to develop insomnia ($p < 0.001$). This association reinforces international ev-

idence linking problematic use of social media and smartphones with lower sleep quality and greater daytime sleepiness[5,6]. Consistently, studies conducted in Bahrain and Saudi Arabia have demonstrated that intensive mobile phone use is associated with anxiety, fatigue, and sleep difficulties[7,8]. In the national context, Peruvian research has also identified a relationship between internet dependency, sleep disorders, and emotional symptoms in young people[10,11], which reinforces the validity of the results obtained in the present investigation.

When analyzing the dimensions of insomnia, it was found that technoaddiction nearly doubles the probability of nocturnal symptom occurrence (OR = 1.983; $p < 0.001$). This suggests that prolonged screen exposure prior to sleep delays sleep onset and fragments rest. The cognitive and emotional stimulation arising from the use of social media or video games may prolong the wakefulness state, alter the circadian cycle, and generate a sensation of non-restorative sleep[6,29]. These results confirm that addictive technological behavior does not merely imply a loss of rest time, but also a neurophysiological activation incompatible with the deep sleep phase.

In contrast, the dimension of "awakening problems" did not show a significant relationship with technoaddiction ($p = 0.286$), indicating that morning difficulties may depend on other factors, such as individual chronotype, school schedules, or sleep compensation strategies during weekends. This result partially coincides with a study that found no effect of smartphone use on awakening quality when contextual variables were controlled[9]. In the Peruvian context, similar studies have reported that morning fatigue tends to be more closely related to academic stress than to technology use[10,11]. Therefore, the absence of significance does not contradict the model, but rather evidences the influence of mediating variables that may attenuate the direct effect of technoaddiction on this dimension of insomnia.

Regarding daytime impact, the results show that technoaddiction doubles the probability of experiencing sleepiness, fatigue, and reduced academic performance (OR = 2.111; $p < 0.001$). This effect confirms empirical evidence associating nighttime device use with lower functional performance and greater daytime exhaustion[5,30]. Studies conducted in Europe and North America indicate that female adolescents show greater vulnerability to daytime fatigue due to hyperconnectivity and emotional sensitivity in the face of digital interactions6. This convergence reinforces the finding that technoaddiction affects physiological recovery processes and emotional balance, reducing energy, concentration, and readiness for learning.

From a theoretical perspective, the findings support three complementary perspectives. First, the instant gratification theory[16] explains that immediate rewards – notifications, reactions, or messages – generate a reinforcement cycle that prolongs connection time and delays sleep. Second, the Media Dependency Theory[17] proposes that the social and emotional needs fulfilled by digital platforms consolidate a dependency relationship that, as it intensifies, interferes with rest rhythms. Finally, the Hyperarousal Theory[18] offers a neurophysiological grounding by asserting that the cognitive and sensory overstimulation produced by screens maintains the nervous system in a state of alertness, hindering the transition to deep sleep. These theories provide a comprehensive explanation of how technoaddiction alters behavioral self-regulation and the biological mechanisms of rest.

Beyond demonstrating the relationship between technoaddiction and insomnia, this study contributes data from the Latin American context using a sample of female adolescents. Considering that the majority of research has been conducted in high-income countries, these results aid in understanding the problem within a different educational and cultural context, characterized by expanding technological access and limited family supervision of screen time. This contribution is particularly relevant, as adolescence constitutes a phase of emotional vulnerability and habit consolidation that may persist into adulthood.

In the applied field, the results provide useful information for the development of school and community interventions aimed at improving sleep hygiene. For educational psychologists, the high rate of insomnia associated with technoaddiction highlights the need to implement digital literacy programs and screen use self-regulation strategies, in addition to incorporating brief technoaddiction assessments into mental health screenings, in order to reduce other potential phenomena such as nomophobia[31] or phubbing[32].

Educational institutions may adopt "nighttime disconnection" policies – such as limiting the assignment of tasks requiring device use after specific hours – and promote workshops for parents on establishing healthy limits for technology use. In the clinical domain, hospitals and children's mental health centers should incorporate questions about technology habits into sleep-related interviews and provide psychoeducational guidance regarding the relationship between compulsive device use and insomnia. Finally, public health authorities may use this evidence to support awareness campaigns about the importance of restricting screen time before sleep, thereby contributing to the prevention of sleep disorders and the improvement of adolescents' academic and emotional well-being.

CONCLUSIONS

The present investigation confirmed that technoaddiction acts as an important risk factor for insomnia in adolescents: students with excessive and compulsive technology use showed greater propensity for overall insomnia, particularly manifested in difficulties initiating or maintaining sleep and in impairments to daytime functioning; in contrast, the relationship with awakening problems was not conclusive. Taken together, these findings support the general objective and two of the three specific objectives, highlighting that dysregulated technological behaviors negatively affect the quality and consequences of sleep in female secondary school students.

This study presents methodological limitations, as it examined only two main variables (technoaddiction and insomnia) and used a single inferential procedure (logistic regression) to test the hypotheses. Furthermore, the sample was non-probabilistic, cross-sectional, and limited to female students from a single educational institution, making generalization of the findings difficult.

At the theoretical level, empirical evidence was insufficient to confirm the influence of technoaddiction on the "awakening problems" dimension, leaving the totality of the proposed hypotheses and their relationship with the Hyperarousal Theory only partially confirmed. This is compounded by the scarcity of prior research that has simultaneously explored both variables in comparable Latin American populations, limiting in-depth contrast with the existing literature.

Moreover, this study did not consider variables related to the duration of electronic device use or sleep and wake schedules — factors that, from the perspective of circadian rhythms, play an important role in adolescent sleep.

To overcome these limitations, future studies should incorporate additional variables (anxiety, chronotype, and sleep hygiene habits) and test more complex models through multivariate analyses or structural equation modeling. Likewise, the use of longitudinal designs and probabilistic samples that include male participants and different regions is recommended, in order to improve the external validity of the results.

It is also recommended to explore mediating and moderating variables capable of explaining the absence of a relationship with awakening problems — such as number of hours of device use, sleep and wake schedules, and weekend sleep compensation — and to continue evaluating the Hyperarousal Theory across different cultural contexts.

Finally, the scarcity of literature on technoaddiction and insomnia in Latin American adolescents underscores the need to replicate and expand research in this area, with the aim of consolidating a more robust theoretical body of knowledge.

CRediT author statement

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All authors have read and agreed to the published version of the manuscript.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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