Ciência & Saúde Coletiva
cienciaesaudecoletiva.com.br
ISSN 1413-8123. v.31, n.4
DOI: 10.1590/1413-81232026314.07002024EN

Excessive daytime sleepiness and health risk behaviors among adolescents: a population-based study

Nayra Suze Souza e Silva http://orcid.org/0000-0002-8420-0821 [1]; Kamila Teles Soares https://orcid.org/0000-0003-1524-6487 [1]; Desirée Sant'Ana Haikal https://orcid.org/0000-0002-0331-0747 [1]; Rosângela Ramos Veloso Silva http://orcid.org/0000-0003-3329-8133 [1]

Abstract *This study aims to analyze excessive daytime sleepiness in relation to health risk behaviors among adolescents. Epidemiological and cross-sectional study carried out with 1st-year high school students from 20 state public schools in the city of Montes Claros, Minas Gerais, Brazil. Data were collected in 2022/2023. The dependent variable was analyzed using the Pediatric Daytime Sleepiness Scale, validated for Brazil. Descriptive, bivariate and multiple analyses were performed using Poisson Regression. 1,616 adolescents participated in the study, among them, 72% had excessive daytime sleepiness, with higher prevalence among girls (PR=1.22), those who studied in the morning (PR=1.35) and full-time (PR=1.35) shifts, those who were in the pre-contemplation stage of behavior change (PR=1.15), those who consumed ultra-processed foods daily (PR=1.09), with severe depressive symptoms (PR=1.16) and with smartphone addiction (PR=1.36). The high prevalence of daytime sleepiness was associated with health risk behaviors among adolescents. Thus, actions that encourage the adoption of healthy lifestyles are necessary to minimize health damage in the short, medium and long term.*

Key words *Sleep quality, Adolescent health, High school, Epidemiological surveys*

[1] Universidade Estadual de Montes Claros. Av. Rui Braga s/n, Vila Mauricéia. 39401-089 Montes Claros MG Brasil. nayrasss8@gmail.com

Introduction

Excessive Daytime Sleepiness (EDS) can be understood as the need to sleep in situations in which a person is expected to be awake and alert, thus not being able to maintain a state of wakefulness[1], which condition is considered a public health problem[2]. The aspects involved in the cause of EDS have been discussed in literature, being considered as a consequence of several behavioral problems, which leads to insufficient or interrupted sleep, sleep disorders, central hypersomnia disorders and other psychiatric medical conditions or use of medications[2,3]. Other factors can also influence this reality, such as the decrease in melatonin production during adolescence, excessive exposure to screens and changes in the rhythm at which the body performs its functions throughout the day[3-7].

Considering sleep problems in adolescence, circadian rhythms undergo changes inherent to each phase of human development, interfering with the sleep pattern, which can also be affected by individual circumstances[4,5]. According to a literature review, 25% to 40% of EDS cases are caused by other sleep problems[8].

The literature presents varying EDS prevalence rates among adolescents. A longitudinal study conducted in China, evaluating EDS in a sample of 7,072 adolescents with average age of around 14 years, identified EDS prevalence of 21.1% among adolescents[9]. A Brazilian study conducted with adolescents aged 10-16 years from public schools identified EDS prevalence of 52.1%[10]. In a study conducted with Argentine adolescents aged 12-18 years, the EDS prevalence found was 71%[7]. These studies, together with Brazilian systematic reviews that compared methodologies, instruments and cutoff points of studies involving EDS and adolescents[11,12], reinforce in their conclusions the need for continued investigations given the scarcity of studies on EDS among adolescents. Thus, considering that sleep plays a fundamental role for the full development of adolescents and that EDS represents a public health problem, and in order to promote a healthier adolescence, the present study aimed to analyze EDS in relation to health risk behaviors among adolescents.

Methods

Study design and participants

This study is part of the ELCAS Project: "Longitudinal Study on Adolescent Behavior regarding Physical Activity and Health". The ELCAS Project was developed in two stages. The 1st stage (baseline) is an epidemiological, cross-sectional and analytical study, while the 2nd stage (follow-up) is a longitudinal and prospective study, carried out 24 months after the baseline. This article uses data from the baseline stage. The study followed recommendations of the Reporting of Observational Studies in Epidemiology (STROBE)[13,14] for observational studies and the Consensus-Based Checklist for Reporting of Survey Studies (CROSS)[15], with a document inserted in the Supplementary Material (https://doi.org/10.48331/SCIELODATA.D4VZUF).

The study population consisted of adolescents of both sexes aged 14-19 years enrolled in the state public school system (urban and rural), who were attending the first year of high school in 2022 and 2023, in the municipality of Montes Claros-MG, Brazil. Located in the northern region of the state of Minas Gerais, Montes Claros had, in 2022, population of approximately 414,240 inhabitants[16].

Study variables and data sources

The dependent variable of this study was EDS, which came from the Pediatric Daytime Sleepiness Scale (PDSS)[17], validated for Brazilian adolescents in 2016[18]. The instrument consists of eight multiple-choice questions that include questions related to the feeling of daytime sleepiness in routine situations, highlighting the frequency with which adolescents feel sleepy while performing school activities, as well as regarding mood, the need to sleep longer and to stay in bed beyond the scheduled time to get up in the morning. The response options follow the Likert scale and have score from 0 to 4 (except for the third question, which has reverse score): 0 = never; 1 = almost never; 2 = sometimes; 3 = often; 4 = always. The final sum of the response options can vary from a minimum of zero points to a maximum of 32 points, indicating greater presence of EDS as the final score increases (closer to 32). To categorize this vari-

able, the study by Meyer *et al.*[19] was followed, which proposed 15 points as the cutoff point for the PDSS instrument[17], indicating the absence of EDS for values below 15.

The selection of independent variables was adapted from the theoretical model proposed by Lima *et al.*[20], namely: sex (male; female), self-declared skin color (white; black/brown/yellow/indigenous), school shift (night; morning; afternoon; full-time), study and work (no; yes), family income (high; medium; low), stages of behavior change (maintenance; action; preparation; contemplation; pre-contemplation), level of physical activity (active; insufficiently active; inactive), active commuting to school (yes; no), daily consumption of ultra-processed foods (no; yes), severe depressive symptoms (no; yes), smartphone addiction (no; yes), body image satisfaction (yes; no), excess body weight (no; yes) and abdominal obesity (no; yes).

Family income was measured using the Brazilian Economic Classification Criteria (CCEB)[21], which presents estimates of monthly household income for socioeconomic strata, classifying incomes as (from highest to lowest): A, B1, B2, C1, C2 and DE. For this study, incomes were categorized as high (A and B1), medium (B2, C1, C2) and low (DE). The stages of behavior change allow identifying individuals who wish to make changes in physical activity compared to those who are not willing to do so. For this instrument, stages are classified as follows: Pre-contemplation (there is no intention to practice physical activity); Contemplation (there is an intention to practice physical activity, but there is still no action); Preparation (there is an intention to practice physical activity and the individual intends to start it in the near future); Action (there is a change in behavior, but the practice time is shorter than six months); Maintenance (the behavior was acquired and maintained, with practice time longer than 6 months)[22].

The short-version of the International Physical Activity Questionnaire (IPAQ), validated and translated for Brazilian adolescents in 2005, was used to verify the level of physical activity of adolescents[23]. The classification followed recommendations from WHO[24] and the Ministry of Health[25], classifying adolescents as active (practicing at least 300 minutes of physical activity per week), insufficiently active (practicing less than 300 minutes of physical activity per week) and inactive (not practicing regular physical activity). To assess the consumption of ultra-processed foods, a questionnaire used in the National School Health Survey (PeNSE)[26] was applied, with questions related to diet, taking into account everything the participant consumed at home, at school and on the street in the seven days prior to data collection. The consumption of ultra-processed foods was defined as the daily consumption of at least one food group (soft drinks/sweets/fast food/processed foods)[27], with variable daily consumption of ultra-processed foods categorized as no and yes.

Depressive symptoms variable was assessed by the Depression, Anxiety and Stress Scale-21 (DASS-21) instrument, validated for Brazil in 2014[28]. DASS-21 is an instrument that measures depression, anxiety and stress separately, consisting of 21 Likert-type questions with four answer options (0-1-2-3). The sum for each domain ranges from 0 to 21 and the final score is multiplied by two. Depressive symptoms (corresponding to items 3, 5, 10, 13, 16, 17 and 21) are classified into the following categories: normal (0 to 9), mild (10 to 13), moderate (14 to 20), severe (21 to 27) and extremely severe (28 or more). For this study, the severe depressive symptoms variable was dichotomously categorized as no (0 to 20) and yes (21 points or more). To assess smartphone addiction, the Smartphone Addiction Inventory (SPAI) instrument[29], validated for Brazil in 2016[30], was used. The scale includes 26 dichotomous items (1 = Yes; 0 = No), classifying smartphone addiction as no (≤8 points) and yes (≥9 points). Body image satisfaction was assessed using the Stunkard (1983) silhouette scale[31], validated for Brazil in 2006[32]. The silhouette scale consists of 18 silhouettes of human figures, 9 male and 9 female, ranging from 1 (very thin) to 9 (very fat). Participants choose two images, one that most closely matches how they perceive themselves and the other that most closely matches how they would like to be. The score is calculated by the difference between the silhouette chosen as ideal and the current one, ranging from -8 to 8. Thus, body image satisfaction variable was categorized as no (values equal to zero) and yes (values different from zero).

Anthropometric variables of excess weight and abdominal obesity were addressed by collecting weight, height and waist circumference measurements, performed/collected by the

researchers, in accordance with WHO recommendations[33] and the techniques used to obtain all measurements followed standardized procedures[34]. Weight was measured using a calibrated digital scale (Digital Magna®), with participants in the center of the scale platform in an anatomical position, dressed in light clothing and barefoot. Height was measured using an individual stadiometer (Alturaexata®), with adolescents, barefoot, standing with their backs to the instrument. Excess weight was based on Body Mass Index (BMI) values according to the following formula: Weight (kg) / Height $(m)^2$. After defining this variable, BMI was categorized with values for sex and age based on cutoff points in percentiles, considering excess weight for the percentile ≥85[35]. Waist circumference was measured using an inextensive and inelastic anthropometric tape, with adolescents dressed, lifting their shirts at the waist region, standing with their abdomen relaxed, arms relaxed at their sides, with the tape placed horizontally at the point of least waist curvature, between the iliac crest and the first costal arch[33], adopting cutoff points proposed by Taylor *et al.*[36], which identify abdominal obesity with waist circumference ≥80th percentile, considering the age and sex of adolescents.

Sampling and procedures

Based on a stratified list provided by the State Department of Education in 2022, Montes Claros-MG had 43 public high schools, totaling a population of 3,765 students enrolled in the first year of high school. Thus, the sample calculation was defined considering the following parameters: prevalence of 50%, confidence level of 95%, error of 3%, deff=1.5 and increment of 10% to compensate for possible losses, resulting in sample size of at least 1,373 adolescent students.

Data collection was carried out in two stages. In the first stage, by probability proportional to size, 20 schools were drawn, and in the second stage, by simple random sampling, classes were drawn. All students in the selected classes were invited to participate in the study. Thus, adolescents of both sexes, in the 1st year of high school, regularly enrolled in the state public education system of Montes Claros-MG in 2022 and 2023 participated in the study. Adolescents who were not present in the classroom at the time of data collection did not participate in the study.

After authorization for the research to be carried out by the 22nd Regional Education Superintendence of the city of Montes Claros-MG, data collection began in September 2022 in person at state public schools of Montes Claros and ended in December 2023. Initially, the data collection team was duly trained to carry out the data collection procedures, with the aim of standardizing the approach to adolescents and the application of questionnaires. A pilot study was carried out in one of the schools to detect possible discrepancies in the research instrument and to evaluate the average response time of the research instrument.

First, adolescents from the selected classes were visited by researchers who informed them about the aims of the research and invited them to participate. Secondly, after being informed about the research and having received the authorization duly signed by their parents and/or guardians, the questionnaire was administered. The average time to respond to the collection instrument was 40 minutes (according to the pilot study).

Statistical analysis

The collected data were double-entered, checked and analyzed using the Statistical Package for the Social Sciences – SPSS® version 22.0. Descriptive and bivariate analyses were performed using Pearson's chi-square test to associate EDS with independent variables. Only variables that presented p-value<0.20 in the bivariate analysis were initially selected to compose the multiple model using Poisson Regression, with robust variance. The selected variables (p<0.20) were all entered together in the model and were removed one by one in decreasing order considering the p-value and the quality of the fit, remaining in the final model only variables that presented descriptive level below 5% (p<0.05). The magnitude of associations was estimated by the adjusted prevalence ratio (PR), 95% confidence interval (CI) and 5% significance level (α≤0.05).

Sensitivity analysis

To reinforce the robustness of findings and ensure that potential confounding factors were not omitted, sensitivity test analyses were performed to confirm the results for variables that did not maintain statistical significance (p<0.005) in the Poisson Regression (considering that variables relevant to the topic under study were not maintained in the final multiple

model). Thus, sensitivity tests were performed through new categorizations of variables and extra multiple model.

For the sensitivity analysis through new categorizations of variables, Poisson Regression was performed and all independent variables described in the study, with recategorization for self-reported skin color (white; black; brown; yellow; indigenous), family income (A; B1; B2; C1; C2; DE), level of physical activity (numerical), overweight (numerical) and abdominal obesity (numerical). The analysis of the extra theoretical model, through Binary Logistic Regression, was composed of all independent variables described in the main study. All these additional analyses are presented in the Supplementary Material (https://doi.org/10.48331/SCIELODATA.D4VZUF).

Ethical aspects

The ELCAS Project was authorized by the State Secretariat of Education of Minas Gerais, approved by the Research Ethics Committee of the State University of Montes Claros (Unimontes) in March 2022, under opinion No. 5.287.269. The study guaranteed the anonymity of adolescents and complied with Resolution No. 466 of 2012 of the National Health Council/Ministry of Health, which deals with research with human beings. The Project was funded by the Minas Gerais State Research Support Foundation - FAPEMIG, through Notice 001/2022 - Universal Demand No. APQ-00711-22.

Results

Of the 3,765 adolescents eligible to participate in the study, 1,634 questionnaires were collected. Of these, 18 were removed due to errors in completing the questions. Thus, 1,616 adolescents were considered to remain in the research, distributed in 20 state schools (18 urban and 02 rural), with average age of 15.3 (±0.7) years. Among adolescents, about half were female (50.4%), 73.9% self-declared as having black/brown/yellow/indigenous skin color, the vast majority (95%) were enrolled in daytime shifts (full-time, morning and afternoon), approximately 80% had medium family income, more than 60% used active commuting to school, 31.3% consumed ultra-processed foods daily and body image dissatisfaction among adolescents was higher (71.1%) than body image satisfaction (28.9%). These and other data are presented in Table 1. Regarding the main study outcome, it was found that 72% (n=1,131) of adolescents presented EDS while the remaining 28% (n=440) did not present this condition (Table 1).

Data in Table 1 also included the bivariate analyses of independent variables in relation to EDS. In this analysis, variables that were associated at level of 20% were sex, self-reported skin color, school shift, stages of behavior change, level of physical activity, active commuting to school, daily consumption of ultra-processed foods, severe depressive symptoms, smartphone addiction and body image satisfaction, and were selected to initially compose the multiple model.

The final multiple model (Table 2) reveals that variables gender, study shift, stages of behavior change, daily consumption of ultra-processed foods, severe depressive symptoms, and smartphone addiction maintained statistically significant association with EDS among adolescents. There was higher prevalence of EDS among female adolescents (PR=1.22; 95%CI 1.13-1.32; p<0.001) and those enrolled in the morning (PR=1.35; 95%CI 1.10-1.65; p=0.004) and full-time (PR=1.35; 95%CI 1.10-1.67; p=0.004) shifts, when compared to night shift students. Regarding the stages of behavior change for the practice of physical activity, there was higher prevalence of the pre-contemplation stage (no intention to practice physical activity) (PR=1.15; 95%CI 1.03-1.28; p=0.012), when compared to adolescents in the maintenance phase (practicing regular physical activity). There was also higher prevalence of EDS among adolescents who consumed ultra-processed foods daily (PR=1.09; 95%CI 1.02-1.16; p=0.009), who presented severe depressive symptoms (PR=1.16; 95%CI 1.09-1.24; p<0.001) and among those who presented smartphones addiction (PR=1.36; 95%CI 1.25-1.47; p<0.001).

The sensitivity analyses performed (Supplementary Material - https://doi.org/10.48331/SCIELODATA.D4VZUF) showed consistent results, validating the accuracy of previously presented results.

Discussion

This study aimed to identify, as main points, the prevalence and health risk factors associated with EDS among adolescent students in the city of Montes Claros, Minas Gerais, Brazil. High

Table 1. Total descriptive analysis and bivariate analysis of excessive daytime sleepiness in relation to independent variables among adolescents. Montes Claros-MG. 2022/2023 (n=1.616).

Variables	Total	Excessive Daytime Sleepiness		p-value
		Absent	Present	
	n (%)	n (%) 440 (28.0)	n (%) 1,131 (72.0)	
Sex				<0.001
Male	801 (49.6)	298 (38.4)	478 (61.6)	
Female	815 (50.4)	142 (17.9)	653 (82.1)	
Self-declared skin color				0.095
White	419 (26.1)	102 (24.8)	309 (75.2)	
Black/Brown/Yellow/Indigenous	1,184 (73.9)	335 (29.1)	815 (70.9)	
Study shift				<0.001
Night	96 (5.9)	39 (42.9)	52 (57.1)	
Morning	963 (59.6)	247 (26.3)	693 (73.7)	
Afternoon	149 (9.2)	53 (36.6)	92 (63.4)	
Full-time	408 (25.2)	101 (25.6)	294 (74.4)	
Study and work*				0.439
No	1,320 (81.9)	355 (27.6)	931 (72.4)	
Yes	291 (18.1)	84 (29.9)	197 (70.1)	
Family income*				0.256
High	164 (12.3)	36 (22.5)	124 (77.5)	
Medium	1,052 (79.0)	289 (28.1)	739 (71.9)	
Low	116 (8.7)	34 (30.6)	77 (69.4)	
Stages of behavior change*				<0.001
Maintenance	443 (27.6)	160 (37.3)	269 (62.7)	
Action	358 (22.3)	107 (30.7)	241 (69.3)	
Preparation	356 (22.2)	78 (22.3)	271 (77.7)	
Contemplation	247 (15.4)	57 (23.8)	183 (76.3)	
Pre-contemplation	199 (12.4)	33 (17.1)	160 (82.9)	
Level of physical activity*				<0.001
Active	1,004 (65.4)	305 (31.3)	669 (68.7)	
Insufficiently active	396 (25.8)	85 (21.8)	305 (78.2)	
Inactive	136 (8.8)	20 (15.4)	110 (84.6)	
Active commuting to school*				0.067
Yes	991 (66.6)	290 (30.0)	677 (70.0)	
No	496 (33.4)	121 (25.4)	356 (74.6)	
Daily consumption of ultra-processed foods*				<0.001
No	1,107 (68.7)	345 (32.1)	729 (67.9)	
Yes	504 (31.3)	95 (19.2)	401 (80.8)	
Severe depressive symptoms*				<0.001
No	1,022 (68.1)	346 (34.7)	650 (65.3)	
Yes	479 (31.9)	66 (14.0)	406 (86.0)	
Smartphone addiction*				<0.001
No	596 (45.1)	256 (44.1)	325 (55.9)	
Yes	726 (54.9)	116 (16.4)	590 (83.6)	
Body image satisfaction*				0.012
Yes	448 (28.9)	142 (32.6)	293 (67.4)	
No	1,101 (71.1)	282 (26.3)	792 (73.7)	
Excess body weight*				0.397
No	643 (76.3)	181 (29.1)	440 (70.9)	
Yes	197 (23.7)	51 (26.0)	145 (74.0)	
Abdominal obesity*				0.474
No	773 (77.8)	210 (27.9)	542 (72.1)	
Yes	220 (22.2)	55 (25.5)	161 (74.5)	

*Variation in n due to loss of information.

Source: Authors.

Table 2. Poisson regression. Adjusted analysis of the prevalence ratio of excessive daytime sleepiness among adolescents. Montes Claros-MG. 2022/2023 (n=1.616).

Variables	PRadjusted (CI95%)	p-value
Sex		
Male	1	
Female	1.22 (1.13-1.32)*	<0.001
Study shift		
Night	1	
Morning	1.35 (1.10-1.65)*	0.004
Afternoon	1.20 (0.94-1.52)	0.133
Full-time	1.35 (1.10-1.67)*	0.004
Stages of behavior change		
Maintenance	1	
Action	1.04 (0.93-1.16)	0.462
Preparation	1.09 (0.98-1.21)	0.101
Contemplation	1.11 (0.99-1.25)	0.070
Pre-contemplation	1.15 (1.03-1.28)*	0.012
Daily consumption of ultra-processed foods		
No	1	
Yes	1.09 (1.02-1.16)*	0.009
Severe depressive symptoms		
No	1	
Yes	1.16 (1.09-1.24)*	<0.001
Smartphone addiction		
No	1	
Yes	1.36 (1.25-1.47)*	<0.001

PR: Prevalence Ratio. 95%CI: 95% Confidence Interval. *Statistically significant values.

Source: Authors.

EDS prevalence (72%) was observed among adolescents, and this result was also observed in other studies contained in the international[7,9] and national literature[10,20]. In the context of adolescence, sleep is of fundamental importance, since the quality of sleep of adolescents directly influences the healthy physical, behavioral, emotional, and cognitive development of these individuals[4].

As for the factors significantly associated with EDS, higher prevalence was obtained among girls, among adolescents in the morning or full-time school shifts, among those who were in the stage of behavior change of pre-contemplation for the practice of physical activity, who consumed ultra-processed foods daily, those with severe depressive symptoms, and those who presented smartphone addiction.

Regarding sex differences, the results of this study showed higher EDS prevalence among girls (PR=1.22), and the same association was found in other locations, such as in studies conducted with Portuguese[37] and Japanese[38] adolescents. Furthermore, Forest *et al.*[39] conducted a study with the aim of investigating sex differences regarding sleep and EDS in a sample of 731 adolescents. The results suggested greater impacts and greater negative interference in daytime functioning for adolescents, which appear to be more complex and multifactorial for girls than for boys. Some biologically based questions may help to understand the higher EDS prevalence among girls. According to a study that analyzed a sample of 3,001 female adolescents, it was found that menstrual pain is related to EDS[40]. These results allow inferring that, since maturation in adolescence occurs differently for boys and girls, this condition ends up by contributing to girls presenting greater EDS.

Higher EDS prevalence was found among adolescents who attended morning and full-time shifts, when compared to those enrolled in the evening shift. In this sense, some studies have shown that the school class schedule influ-

ences different aspects related to sleep, including EDS[41,42]. A literature review study aimed to address adolescent sleep indicates that delaying the start time of classes in the morning can be an efficient strategy to improve students' sleep health[41]. In an intervention study conducted in Brazil with the participation of 38 high school adolescents, which compared the effects of delaying the start time of classes by one hour over a three-week period, no significant change in the time of sleep onset was found, but such intervention prolonged sleep time, reflecting improvements in sleep patterns, subjective sleepiness and mood of adolescents[42].

Among adolescents under study, greater EDS associated with stages of behavior change for the practice of physical activity was also observed, with an association being observed among those who were in the pre-contemplation stage, when compared to adolescents who had been regularly practicing physical activity for at least six months (maintenance stage). Considering that the quality of sleep in adolescents is related to behavioral factors[20], in addition to the association with EDS, it is believed that the pre-contemplative stage of behavior change may represent a barrier to changing other healthy habits, considering that regular physical activity in adolescence is associated with better sleep patterns[43]. A study conducted by Lima *et al.*[20] with Brazilian adolescents aged 18-19 years, evaluated, among other aspects, the relationship between modifiable behavioral risk factors and EDS in adolescents. In this study, association was found between physical inactivity and EDS, a result that is similar to that found in the present study. This finding highlights the association of this modifiable behavior with EDS, and in addition, it shows the confrontation with which it was found, in which adolescents in the pre-contemplative stage, who demonstrate resistance to changing their behaviors, presented greater EDS.

Higher prevalence of daily consumption of ultra-processed foods was associated with EDS among adolescents. A study conducted with Spanish adolescents aged 12-17 years demonstrated that those who had high adherence to the Mediterranean diet were more likely to meet sleep recommendations (OR=1.52, 95%CI 1.12-2.06) and less likely to report at least one sleep-related problem, in which EDS was included (OR=0.56, 95%CI 0.43-0.72)[44]. Science has shed light on the benefits of adolescents adhering to the Mediterranean diet, which prioritizes the consumption of natural foods, such as whole grains, fruits, vegetables and legumes. This has been linked to multiple positive health outcomes, and specifically among adolescents, a relationship with better sleep quality, quality of life and also with academic performance has been observed[45-47].

Considering mental health problems, the results of this study showed that the presence of severe depressive symptoms was associated with higher EDS prevalence among adolescents, indicating similarity with a meta-analysis study carried out with 49 studies published between 2014 and 2020, which identified strong association between EDS and depressive symptoms[48]. Another study also conducted with adolescents found association between depressive symptoms and sleepiness, pointing out that this association can be observed as a residual symptom of depression and as an important marker of the severity of this condition[49].

The use of smartphones, especially dependence on this electronic device, has also been shown to be a risk behavior for EDS. Different studies have evaluated the association between screen use and EDS[6,7,50]. Specifically regarding smartphone use, a study carried out in Argentina included a sample of 1,257 adolescents aged 12-18 years and assessed the relationship between screen time, sleep characteristics, EDS and academic performance, demonstrating that screen use negatively affected nighttime sleep, daytime sleepiness and academic performance[7]. A literature review study involving 26 articles conducted with adolescents identified that excessive use of digital screens remained associated with poor quality and shorter sleep duration, with the main consequences being nighttime awakenings, longer sleep latency and daytime sleepiness, highlighting especially the influence of cell phone use before bedtime on these results[6].

Regarding sensitivity analyses, it was possible to observe with the results found that even when recategorizing variables, income, excess weight and abdominal obesity did not maintain statistical significance at 20% level in the bivariate analysis. However, variables skin color and physical activity were statistically significant in relation to sleep in the bivariate analysis ($p<0.20$), but similarly to the multiple model of the study, they did not remain statistically significant in the final model of the sensitivity test, in which the same variables of the main model remained significant.

Regarding the sensitivity analysis through Binary Logistic Regression, the result of the

final multiple model was almost the same, with all variables contained in the main model remaining in the model and, in addition to variable body image satisfaction. This variable indicated that adolescents who were dissatisfied with their body image were more likely of having excessive daytime sleepiness (OR=1.37; 95%CI 1.01-1.85; p=0.041). Thus, the sensitivity analysis was elaborated with the intention of demonstrating that, even with other types of approaches, the resulting variables associated with excessive daytime sleepiness among adolescents are not an effect of the analysis but rather of the variable of interest.

Some limitations should be mentioned to better interpret the results of this study. The use of an indirect method with the application of a self-reported questionnaire answered by adolescents is characterized as a limitation. In addition, the research was conducted only with first-year high school students from public schools in the city of Montes Claros-MG, which could restrict the results to other populations, such as students from private schools or other locations in Brazil, who have characteristics different from the northern region of Minas Gerais. However, the study was constructed with variables from validated and prestigious instruments in literature, including the dependent variable EDS and other independent variables. Study strengths include its methodological rigor, the calibration of researchers and the physical collection of anthropometric data.

Conclusion

This study found significant EDS prevalence (72%) among first-year high school adolescents from public schools. Higher EDS prevalence was observed among girls, among adolescents enrolled in the morning or full-time shifts, those who were in the stage of behavior change of pre-contemplation for the practice of physical activity, who consumed ultra-processed foods daily, with severe depressive symptoms and those with smartphone addiction.

The results of this study confirmed that EDS has multifactorial causes, with regard to the association of behavioral, environmental and emotional factors. In addition to theoretical issues, it is expected that these findings can support interventions that aim to seek better quality of sleep in adolescence and, consequently, the construction of a healthier society. To this end, interdisciplinary actions can be implemented, in a joint action between the scientific community, families and governments, in order to provide better social, physical and mental development for adolescents.

Collaborations

NSS Silva participated in the conception and design of the study, data analysis and interpretation, article writing, and approval of the version to be published. KT Soares participated in the data analysis and interpretation, article writing, and approval of the version to be published. DS Haikal participated in the conception and design of the study, critical review of the article, and approval of the version to be published. RRV Silva participated in the conception and design of the study, data analysis and interpretation, article writing, and approval of the version to be published.

Acknowledgments

The authors would like to thank adolescents for their participation, the support of the Office of the Vice-Rector for Graduate Studies at Unimontes, FAPEMIG for funding the research and for the research incentive grant to RRV Silva, and CNPq for the productivity grant to DS Haikal.

Data availability statement

The data sources adopted in the research are indicated in the article's body. The dataset for this article is available in the SciELO Data repository in the Ciência & Saúde Coletiva Dataverse, at the link: https://doi.org/10.48331/SCIELODATA.D4VZUF.

References

1. Leger D, Stepnowsky C. The economic and societal burden of excessive daytime sleepiness in patients with obstructive sleep apnea. *Sleep Med Rev* 2020; 51:101275.
2. Pérez-Carbonell L, Mignot E, Leschziner G, Dauvilliers Y. Understanding and approaching excessive daytime sleepiness. *Lancet* 2022; 400(10357):1033-1046.
3. Illingworth G. The challenges of adolescent sleep. *Interface Focus* 2020; 10(3):20190080.
4. Mason GM, Lokhandwala S, Riggins T, Spencer RM. Sleep and human cognitive development. *Sleep Med Rev* 2021; 57:101472.
5. Poza JJ, Pujol M, Ortega-Albás JJ, Romero O. Melatonin in sleep disorders. *Neurología* 2022; 37(7):575-585.
6. Silva SSD, Silveira MACD, Almeida HCRD, Nascimento MCPD, Santos MAMD, Heimer MV. Uso de telas digitais por adolescentes e associação com a qualidade do sono: uma revisão sistemática. *Cad Saude Publica* 2022; 38, e00300721.
7. Pérez-Chada D, Bioch SA, Schönfeld D, Gozal D, Perez-Lloret S, Sleep in Adolescents Collaborative study group. Screen use, sleep duration, daytime somnolence, and academic failure in school-aged adolescents. *Plos One* 2023; 18(2):e0281379.
8. Bruni O. Approach to a sleepy child: Diagnosis and treatment of excessive daytime sleepiness in children and adolescents. *Euro J Pediatric Neurol* 2023; 42:97-109.
9. Liu ZZ, Jia CX, Liu X. Excessive daytime sleepiness mediates the relationship between insomnia symptoms and suicidal behavior in adolescents. *Sleep* 2022; 45(11):zsac221.
10. Anacleto TS, Borgio JGF, Louzada FM. Daytime sleepiness in elementary school students: the role of sleep quality and chronotype. *Rev Saude Publica* 2022; 56:63.
11. Meyer C, Ferrari GJ, Barbosa DG, Andrade RD, Pelegrini A, Felden ÉPG. Análise da sonolência diurna em adolescentes por meio da pediatric daytime sleepiness scale: revisão sistemática. *Rev Paul Pediatr* 2017; 35:351-360.
12. Bajerski AE, Jesus ICD, Menezes-Junior FJD, Leite N. Instruments for assessment of excessive daytime sleepiness in Brazilian children and adolescents: Systematic review. *Rev Paul Pediatr* 2022; 40:e2020230.
13. Von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP; STROBE Initiative. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *J Clin Epidemiol* 2008; 61(4):344-349.
14. Malta M, Cardoso LO, Bastos FI, Magnanini MMF, Silva CMFP. STROBE initiative: guidelines on reporting observational studies. *Rev Saude Publica* 2010; 44(3):559-565.

15. Sharma A, Minh DNT, Luu LTT, Nam NH, Ng SJ, Abbas KS, Huy NT, Marušić A, Paul CL, Kwok J, Karbwang J, de Waure C, Drummond FJ, Kizawa Y, Taal E, Vermeulen J, Lee GHM, Gyedu A, To KG, Verra ML, Jacqz-Aigrain ÉM, Leclercq WKG, Salminen ST, Sherbourne CD, Mintzes B, Lozano S, Tran US, Matsui M, Karamouzian M. A Consensus-Based Checklist for Reporting of Survey Studies (CROSS). *J Gen Intern Med* 2021; 36(10):3179-3187.
16. Instituto Brasileiro de Geografia e Estatística (IBGE). *Cidades e Estados* [Internet]. 2022 [acessado 2024 jun 16]. Disponível em: https://www.ibge.gov.br/cidades-e-estados/mg/montes-claros.html.
17. Drake C, Nickel C, Burduvali E, Roth T, Jefferson C, Badia P. The pediatric daytime sleepiness scale (PDSS): sleep habits and school outcomes in middle-school children. *Sleep* 2003; 26(4):455-458.
18. Felden ÉP, Carniel JD, Andrade RD, Pelegrini A, Anacleto TS, Louzada FM. Translation and validation of the pediatric daytime sleepiness scale (PDSS) into Brazilian Portuguese. *J Pediatr* 2016; 92:168-173.
19. Meyer C, Barbosa DG, Ferrari Junior GJ, Andrade RD, Silva DAS, Pelegrini A, Felden ÉPG. Proposal of cutoff points for pediatric daytime sleepiness scale to identify excessive daytime sleepiness. *Chronobiol Int* 2018; 35(3): 303-311.
20. Lima RJCP, Batalha MA, Ribeiro CCC, Lima Neto PM, Silva AAMD, Batista RFL. Fatores de risco comportamentais modificáveis para DNT e sono em adolescentes brasileiros. *Rev Saude Publica* 2023; 57:60.
21. Associação Brasileira de Estudos Populacionais (ABEP). *Critério Brasil* [Internet]. 2022 [acessado 2024 jun 16]. Disponível em: https://www.abep.org/criterio-brasil.
22. Dumith SDC, Domingues MR, Gigante DP. Estágios de mudança de comportamento para a prática de atividade física: uma revisão da literatura. *Rev Bras Cineant Des Hum* 2008; 10(3):301-307.
23. Guedes DP, Lopes CC, Guedes JERP. Reprodutibilidade e validade do Questionário Internacional de Atividade Física em adolescentes. *Rev Bras Med Esporte* 2005; 11:151-158.
24. Organização Mundial da Saúde (OMS). *Diretrizes da OMS Para atividade física e comportamento sedentário* [Internet]. 2020 [acessado 2024 jun 16]. Disponível em: https://ws.santabarbara.sp.gov.br/instar/esportes/downloads/guia_AF_OMS.pdf.
25. Brasil. *Guia de atividade física para a população brasileira* [Internet]. 2022 [acessado 2024 jun 16]. Disponível em: https://bvsms.saude.gov.br/bvs/publicacoes/guia_atividade_fisica_populacao_brasileira.pdf.
26. Instituto Brasileiro de Geografia e Estatística (IBGE). *Pesquisa Nacional de Saúde do Escolar - 2015*. Rio de Janeiro: IBGE; 2016.
27. Monteiro CA, Cannon G, Moubarac JC, Levy RB, Louzada MLC, Jaime PC. The UN Decade of Nutrition, the NOVA food classification and the trouble with ultra-processing. *Public Health Nutr* 2018; 21:5-17.
28. Vignola RCB, Tucci AM. Adaptation and validation of the depression, anxiety and stress scale (DASS) to Brazilian Portuguese. *J Affect Disor* 2014; 155:104-109.
29. Lin YH, Chang LR, Lee YH, Tseng HW, Kuo TB, Chen SH. Development and validation of the Smartphone Addiction Inventory (SPAI). *PloS One* 2014; 9(6):e98312.
30. Khoury JM. *Tradução, adaptação e validação de uma versão brasileira do inventário de dependência de smartphone (SPAI Para o rastreamento de dependência de smartphone* [dissertação]. Belo Horizonte: Universidade Federal de Minas Gerais; 2016.
31. Stunkard AJ, Sorensen T, Schulsinger F, Kety SS, Rowland LP, Sidman RL, Matthysse SW. Use of the Danish Adoption Register for the study of obesity and thinness. *Genetics Neurol Psy Disor* 1983; 115-120.
32. Scagliusi FB, Alvarenga M, Polacow V, Cordás TA, Queiroz GKO. Concurrent and discriminant validity of the Stunkard's figure rating scale adapted into Portuguese. *Appetite* 2006; 47:77-82.
33. World Health Organization (WHO). *Physical status: the use and interpretation of anthropometry: a report of a WHO expert committee*. Geneva: WHO; 1995.
34. Lohman TG, Roche AF, Martorell R. *Anthropometric standardization reference manual*. Champaign: Human Kinetics; 1988.
35. World Health Organization (WHO). *BMI-for-age (5-19 years)*. Washington, D.C.: WHO; 2007.
36. Taylor RW, Jones IE, Williams SM, Goulding A. Evaluation of waist circumference, waist-to-hip ratio, and the conicity index as screening tools for high trunk fat mass, as measured by dual-energy X-ray absorptiometry, in children 3-19y. *Am J Clin Nutr* 2000; 72:490-495
37. Pucci S, Almeida AC, Pereira MG. Health Behaviors and Sleep Quality in Portuguese Adolescents: The Moderating Role of Age and Gender. *Clinic Health* 2024; 35(1):5-12.
38. Sasawaki Y, Inokawa H, Obata Y, Nagao S, Yagita K. Association of social jetlag and eating patterns with sleep quality and daytime sleepiness in Japanese high school students. *J Sleep Research* 2023; 32(2):e13661.
39. Forest G, Gaudreault P, Michaud F, Green-Demers I. Gender differences in the interference of sleep difficulties and daytime sleepiness on school and social activities in adolescents. *Sleep Medic* 2022; 100:79-84.
40. Dong QY, Yang XF, Liu BP, Zhang YY, Wan LP, Jia CX. Menstrual pain mediated the association between daytime sleepiness and suicidal risk: A prospective study. *J Affect Disord* 2023; 328:238-244.
41. Mousavi Z, Troxel WM. Later school start times as a public health intervention to promote sleep health in adolescents. *Cur Sleep Medic Reports* 2023; 9(3):152-160.
42. Araújo LBG, Bianchin S, Pedrazzoli M, Louzada FM, Beijamini F. Multiple positive outcomes of a later school starting time for adolescents. *Sleep Health* 2022; 8(5):451-457.

43. Bello B, Mohammed J, Useh U. Effectiveness of physical activity programs in enhancing sleep outcomes among adolescents: a systematic review. *Sleep Breath* 2023; 27(2):431-439.
44. López-Gil JF, Smith L, Victoria-Montesinos D, Gutiérrez-Espinoza H, Tárraga-López PJ, Mesas AE. Mediterranean dietary patterns related to sleep duration and sleep-related problems among adolescents: the EHDLA study. *Nutrients* 2023; 15(3):665.
45. Romero-Robles MA, Ccami-Bernal F, Ortiz-Benique ZN, Pinto-Ruiz DF, Benites-Zapata VA, Patiño DC. Adherence to Mediterranean diet associated with health-related quality of life in children and adolescents: a systematic review. *BMC Nutrition* 2022; 8(1):57.
46. Boraita RJ, Alsina DA, Ibort EG, Torres JMD. Factors associated with adherence to a Mediterranean diet in adolescents from La Rioja (Spain). *Bri J Nutrition* 2022; 128(7):1425-1432.
47. Rosi A, Giopp F, Milioli G, Melegari G, Goldoni M, Parrino L, Scazzina F. Weight status, adherence to the Mediterranean diet, physical activity level, and sleep behavior of Italian junior high school adolescents. *Nutrients* 2020; 12(2):478.
48. O'Callaghan VS, Couvy-Duchesne B, Strike LT, McMahon KL, Byrne EM, Wright MJ. A meta-analysis of the relationship between subjective sleep and depressive symptoms in adolescence. *Sleep Med* 2021; 79:134-144.
49. Boz S, Lanquart JP, Mungo A, Delhaye M, Loas G, Hein M. Risk of excessive daytime sleepiness associated to major depression in adolescents. *Psy Quarterly* 2021; 92(4):1473-1488.
50. Burnell K, Garrett SL, Nelson BW, Prinstein MJ, Telzer EH. Daily links between objective smartphone use and sleep among adolescents. *J Adolesc* 2024; 96(6):1171-1181.

Article submitted 24/04/2024
Approved 29/01/2025
Final version submitted 31/01/2025

Chief editors: Maria Cecília de Souza Minayo, Romeu Gomes, Antônio Augusto Moura da Silva, Vania de Matos Fonseca