



## Association of physical activity, screen time, and sleep recommendations with excess weight in adolescents Asociación de actividad física, tiempo de pantalla y sueño con exceso de peso en adolescentes

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### Abstract

**Objective:** This study aims to analyze the prevalence of adherence to physical activity, screen time, and sleep recommendations and their association with excess weight in high school adolescents from the state public network of Pernambuco, Brazil.

**Methods:** A cross-sectional study was conducted with 4,203 adolescents aged 14 to 19 years. Data were collected using a translated and validated version of the Global School-Based Student Health Survey (GSHS). The study assessed adherence to recommendations for Moderate to Vigorous Physical Activity (MVPA), screen time (ST), and sleep duration. Logistic regression analysis was used to examine the associations between these behaviors and excess weight, adjusting for age, race, and maternal education.

**Results:** Only 2.68% of adolescents met the combined recommendations for MVPA, ST, and sleep. The total proportion of obese adolescents was 12.3%, with a higher prevalence among girls (13.4%) compared to boys (10.9%). Male adolescents who did not meet the MVPA recommendation had a 1.53 times higher chance of being obese (95% CI: 1.11; 2.12), and those who did not meet the ST recommendation had a 1.60 times higher chance of being obese (95% CI: 1.11; 2.31).

**Conclusions:** Low adherence to physical activity, screen time, and sleep recommendations is associated with higher excess weight rates among adolescents in Pernambuco, Brazil, particularly in boys. Public health strategies promoting these behaviors are essential to combat obesity, with a focus on gender-specific interventions.

### Keywords

Adolescents, lifestyle behaviors, movement behaviors, obesity.

### Resumen

**Objetivo:** Este estudio tiene como objetivo analizar la prevalencia de la adherencia a las recomendaciones de actividad física, tiempo de pantalla y sueño, así como su asociación con el exceso de peso en adolescentes de la educación secundaria de la red pública estatal de Pernambuco, Brasil.

**Métodos:** Se realizó un estudio transversal con 4.203 adolescentes de 14 a 19 años. Los datos fueron recolectados mediante una versión traducida y validada de la Global School-Based Student Health Survey (GSHS). Se evaluó la adherencia a las recomendaciones de Actividad Física Moderada a Vigorosa (AFMV), tiempo de pantalla (TP) y duración del sueño. Se utilizó análisis de regresión logística para examinar las asociaciones entre estos comportamientos y el exceso de peso, ajustando por edad, raza y nivel educativo materno.

**Resultados:** Solo el 2,68% de los adolescentes cumplió con las recomendaciones combinadas de AFMV, TP y sueño. La proporción total de adolescentes con obesidad fue del 12,3%, con mayor prevalencia en las chicas (13,4%) en comparación con los chicos (10,9%). Los adolescentes varones que no cumplieron con la recomendación de AFMV tuvieron 1,53 veces más probabilidad de presentar obesidad (IC95%: 1,11; 2,12), y aquellos que no cumplieron con la recomendación de TP tuvieron 1,60 veces más probabilidad de presentar obesidad (IC95%: 1,11; 2,31). **Conclusiones:** La baja adherencia a las recomendaciones de actividad física, tiempo de pantalla y sueño se asocia con mayores tasas de exceso de peso entre adolescentes de Pernambuco, Brasil, particularmente en los varones. Las estrategias de salud pública que promuevan estos comportamientos son esenciales para combatir la obesidad, con un enfoque en intervenciones específicas por género.

### Palabras clave

Adolescentes, comportamientos de estilo de vida, comportamientos de movimiento, obesidad.



## Introduction

Overweight and obesity are public health problems worldwide (Abarca-Gómez et al., 2017; Lobstein et al., 2024; Phelps et al., 2024), especially in childhood and adolescence (Phelps et al., 2024; WHO, 2024). It has been observed that the prevalence of overweight has increased over the years, with more than one billion obese people currently (Phelps et al., 2024). It is estimated that 159 million children and adolescents are obese, representing a fourfold increase over the past 30 years (Phelps et al., 2024). In Brazil, the National Health Survey indicated that the prevalence of overweight and obesity in adolescents was approximately 19.4% and 6.7% (Brazil, 2020). These alarming conditions have drawn attention to lifestyle changes in this population.

Given this worrying scenario, several studies suggest that high levels of Moderate to Vigorous Physical Activity (MVPA), low Screen Time (ST), and adequate sleep duration have been associated with a series of health benefits (Rollo et al., 2020; Montalt-García et al., 2023). These behaviors gain even more relevance considering that environmental factors can contribute to body weight dysregulation (Nicolaïdis, 2019). Current guidelines recommend that adolescents engage in at least 60 minutes of MVPA daily, limit ST to up to two hours, and have a sleep duration of 8 to 10 hours per night (Tremblay et al., 2016). The recommendations focus on these behaviors throughout the day, referred to in the literature as 24-hour movement behavior (Tremblay et al., 2016), since they are understood as modifiable lifestyle behaviors and fundamental for promoting adolescent health (López-Gil et al., 2023; Rollo et al., 2020).

The prevalence of meeting the recommendations is very low, with only 2.68% of adolescents meeting the PA, ST, and sleep recommendations together (Tapia-Serrano et al., 2022), becoming a public health challenge, as they are important for optimal health (Rollo et al., 2020). Consistent evidence, including systematic reviews, shows that adolescents who meet the recommendations are less likely to be obese, unlike their peers who do not meet them, presenting a higher chance of obesity (López-Gil et al., 2023; Rollo et al., 2020). Additionally, findings indicate that girls are more disadvantaged than boys when they do not meet these recommendations (López-Gil et al., 2023).

Considering that PA, ST, and sleep can interact and influence health together, studies have sought to analyze patterns and combinations of these behaviors in adolescents. Although some studies have been conducted in low- and middle-income countries, few have examined associations between behaviors specifically in this age group. This is important to fill this gap, since a large proportion of overweight or obese children and adolescents in the world live in low- and middle-income countries (Phelps et al., 2024), such as Brazil, seeking to analyze the scenario in this region. Understanding the associations between adolescent behaviors and excess weight may be important for the development of behavioral change strategies for this population, considering the socioeconomic and cultural context of this region, which is still little explored in the literature. Therefore, the objective of this study is to analyze the prevalence of compliance with physical activity recommendations, screen time, and sleep, and their association with excess weight in high school adolescents from the state public school system of Pernambuco, Brazil.

## Method

This is a cross-sectional study, conducted as part of two epidemiological surveys, one school-based and state-wide, entitled: Exposure to alcoholic beverages, tobacco, and other drugs and screening for common mental disorders in adolescents in the state of Pernambuco: an epidemiological study to support a proposal for School - RAPS integration, and another school-based and regional, entitled: Association between physical activity, sedentary behavior, motor competence, sleep quality, and adiposity indicators in high school students from the Metropolitan Region of Recife, conducted between 2022 and 2023.

The studies were approved by the Human Research Ethics Committee of the Pernambuco State Hematology and Hemotherapy Foundation (opinion no.: 4.449.705/HEMOPE), and by the Human Research Ethics Committee of the Federal University of Pernambuco (opinion no.: 5.921.335/UFPE). All parents/guardians were informed about the study, and participation was authorized by signing the Free and Informed Assent Term (TALE) and the Free and Informed Consent Term (TCLE).



## Participants

Considering that the present research comes from two cross-sectional epidemiological studies, the target population was composed of high school students enrolled in public schools in the state of Pernambuco and also specifically in the Metropolitan Region of Recife. Students of both sexes, aged between 14 and 19 years, from the schools selected for the research were included. The participants were selected through a two-stage cluster sampling process. In the first stage, schools were randomly selected, stratified by size and region. In the second stage, classes from the selected schools were randomly chosen, taking into account the distribution by shift and grade.

To be eligible for this study, adolescents had to be between 14 and 19 years old, be students of the schools selected to participate in the research, and have been authorized by their parents or guardians to participate in the research through the TALE and TCLE. Those who exceeded the 24-hour time in the self-report of Physical Activity (PA), Screen Time (ST), and sleep behaviors, and those who did not agree to participate in the anthropometric assessment were excluded. The 24-hour eligibility criterion was adopted due to the possibility of adolescents overestimating the exposure time to behaviors. Thus, the mathematical expression “24h - TS > MVPA + ST” was established to determine the exclusion of adolescents' data. This expression requires that the total wakefulness time (24 hours minus sleep time) be greater than the sum of PA and ST time for the data to be considered valid.

## Procedure

Information was obtained using a translated, self-administered, and previously tested version of the Global School-Based Student Health Survey (GSHS). This is an instrument proposed by the World Health Organization in partnership with other organizations to be used by different countries (PAHO, n.d.). In this instrument, the questions must be translated into the appropriate language for the students and submitted to a pilot test to analyze comprehension (WHO, n.d.). For the present study, a pilot test was conducted, in which the reproducibility coefficients of the instrument ranged from 0,77 to 1,0.

The questionnaire was administered in the classroom, without the presence of teachers, to all students present who agreed to participate in the study. Initially, the research objectives were explained, clarifying to the students that the information provided would be kept confidential, would not influence their school performance, and would only be used for research purposes.

Information on excess weight (dependent variable) was obtained through Body Mass Index (BMI) weight status categories, based on BMI/age percentiles according to sex. BMI was obtained from the ratio of body mass to height squared. Body mass and height were objectively measured using a previously calibrated Plenna electronic scale (Sport model) and a Plenna stadiometer (model 206; São Paulo, Brazil). Adolescents were classified as normal weight up to the 85th percentile, and as excess weight from the 85th percentile onwards.

The independent variables were Physical Activity (PA), Screen Time (ST), and sleep. Information on PA was obtained from four questions: “During a typical or normal week, on how many days do you engage in moderate to vigorous physical activities?”; “On the days you engage in moderate to vigorous physical activities, how long per day does this practice last?”; “During the last 7 days, on how many days did you engage in moderate to vigorous physical activities?”; “In the last 7 days, on the days you engaged in moderate to vigorous physical activities, how long per day did this practice last?”. Adolescents were categorized as meeting and not meeting the physical activity recommendation, corresponding to engaging in physical activity equal to or greater than 420min/week and less than 420min/week, respectively.

Information on ST was based on screen time, obtained from eight questions about adolescents' behavior on weekdays and weekends regarding time spent on TV, computer, video games, and cell phone or tablet. The cut-off points used were  $\leq 2$  hours/day meeting the recommendation and  $> 2$  hours/day not meeting the recommendation. For the sleep variable, two questions were used: “On a normal week, on average, how many hours do you sleep per day?”; “On a normal weekend, on average, how many hours do you sleep per day?”. The variable was represented as meeting and not meeting the recommendation, considering those with sleep time between 8 to 10 hours/day as meeting the recommendation.

The SPHYNX® software (Sphynx Software Solutions Incorporation, Washington, United States) for tablet (Samsung Galaxy A7, Suwon, South Korea) was used, so after each workday, data was uploaded to a server so that at the end of data collection, the tabulation phase was also completed. For the registration



of anthropometric measurements, researchers filled out a specific form for objective measurements that were double-entered into Microsoft Office software (Excel version 2019). The databases were merged using all variables of interest from the selected datasets. To integrate information from different sources, the merge command was used in Stata software to merge two databases through common variables. This procedure allows related observations to be combined, ensuring that data concerning the same units of analysis are correctly merged. All variables of interest from both databases were selected beforehand, and the merge was performed based on the type of relationship between the data. After merging, the resulting dataset was reviewed to verify the consistency of the observations and ensure that the data were complete for subsequent analyses.

### Data analysis

For data analysis, the Stata version 17.0 statistical package (StataCorp LP®, College Station, Texas, United States) was used. Descriptive analyses were used to report the characteristics of the sample, prevalence of excess weight, and meeting PA, ST, and sleep recommendations, based on the distribution of relative and absolute frequencies. Pearson's chi-square test was used to examine differences between proportions by sex.

To analyze the association between isolated behaviors and excess weight, binary logistic regression analysis was used. Analyses were adjusted for age, race, and maternal education. The adjustment of logistic regression models was evaluated by the Hosmer-Lemeshow test. The modeling process adopted was the "Enter" input method, in this way all variables were included and remained in the regression model. Variables significantly associated were those with a p-value less than 0.05.

## Results

A total of 4,203 adolescents' data were considered valid, and their characteristics are presented in Table 1. The sample included adolescents aged 14 to 19 years, of both sexes, of which 2,401 (57.1%) were girls. Most adolescents were non-white (74.8%), with mothers who studied more than eight years (51.6%). Regarding weight status, 12.3% of adolescents were obese, however girls had a higher prevalence (13.4%) compared to boys (10.9%). About 27.7% of adolescents reported engaging in more than 420 minutes of Moderate to Vigorous Physical Activity (MVPA) per week, 28.5% had up to two hours of ST based on screen time per day, and 26.5% had a sleep duration between 8 to 10 hours daily.

Table 1. Characteristics of high school adolescents from the state public network of Pernambuco, Brazil.

Variable	Boys (n= 1,802)	Girls (n= 2,401)	Total (n=4,203)	p
Age, n (%)				< 0.01
14 years	27 (1.5)	51 (2.1)	78 (1.9)	
15 years	333 (18.5)	526 (21.9)	859 (20.4)	
16 years	491 (27.3)	696 (29.0)	1,187 (28.2)	
17 years	496 (27.5)	656 (27.3)	1,152 (27.4)	
18 years	370 (20.5)	406 (16.9)	776 (18.5)	
19 years	85 (4.7)	66 (2.8)	151 (3.6)	
Race, n (%)				0.97
White	454 (25.2)	606 (25.2)	1,060 (25.2)	
Non-white	1,348 (74.8)	1,795 (74.8)	3,143 (74.8)	
Maternal education, n (%)				0.01
< 8 years of study	827 (45.9)	1,207 (50.3)	2,034 (48.4)	
≥ 8 years of study	975 (54.1)	1,194 (49.7)	2,169 (51.6)	
Weight status, n (%)				< 0.01
Underweight	225 (12.5)	135 (5.6)	360 (8.6)	
Normal weight	1,245 (69.1)	1,676 (69.8)	2,921 (69.5)	
Overweight	135 (7.5)	269 (11.2)	404 (9.6)	
Obesity	197 (10.9)	321 (13.4)	518 (12.3)	
Physical Activity, n (%)				< 0.01
Meets	720 (40.0)	444 (18.5)	1,164 (27.7)	
Does not meet	1,082 (60.0)	1,957 (81.5)	3,039 (72.3)	
Screen Time, n (%)				0.77
Meets	509 (28.2)	688 (28.6)	1,197 (28.5)	
Does not meet	1,293 (71.8)	1,713 (71.4)	3,006 (71.5)	
Sleep, n (%)				0.96
Meets	477 (26.5)	637 (26.5)	1,114 (26.5)	
Does not meet	1,325 (73.5)	1,764 (73.5)	3,089 (73.5)	

p: p-value.



The association between meeting the recommendations and excess weight is presented in Table 2. It was found that male adolescents who do not meet the MVPA recommendation had a 1.53 (95% CI: 1.11; 2.12) higher chance of being excess weight compared to adolescents who meet the recommendation. Additionally, male adolescents who do not meet the ST recommendation had a 1.60 (95% CI: 1.11; 2.31) higher chance of being excess weight compared to adolescents who meet the recommendation. It was also observed that for the total sample, boys and girls who do not meet the ST recommendation had a 1.31 (95% CI: 1.06; 1.63) higher chance of being excess weight compared to adolescents who meet the recommendation. No associations were observed for physical activity, screen time, and sleep among girls.

Table 2. Association between meeting the recommendations and excess weight in high school adolescents from the state public network of Pernambuco, Brazil.

	Boys (n= 1,802)	Girls (n= 2,401)	Total (n=4,203)
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Physical Activity			
Meets	1	1	1
Does not meet	1.53 (1.11;2.12) *	0.85 (0.64;1.15)	1.13 (0.91;1.41)
Screen Time			
Meets	1	1	1
Does not meet	1.60 (1.11;2.31) *	1.18 (0.90;1.55)	1.31 (1.06;1.63)*
Sleep			
Meets	1	1	1
Does not meet	1.05 (0.74;1.48)	1.04 (0.80;1.37)	1.04 (0.84;1.29)

OR: Odds Ratio; 95% CI: 95% Confidence Interval; PA: Physical Activity; ST: Screen Time.

Note: Adjusted for age, race, and maternal education. Hosmer-Lemeshow test: Boys (chi-square = 303.60; p-value = 0.4471); Girls (chi-square = 331.36; p-value = 0.0829); Total (chi-square = 648.17; p-value = 0.1038).

## Discussion

This study analyzed the association between the prevalence of meeting Moderate to Vigorous Physical Activity (MVPA), Screen Time, and sleep recommendations with excess weight in high school adolescents from the state public network of Pernambuco. A higher chance of excess weight was identified in male adolescents who do not meet the Physical Activity (PA) and Screen Time (ST) recommendations.

The total proportion of obese adolescents was 12.3%, being higher among girls (13.4%) than among boys (10.9%). These values are almost double the prevalence observed in the National Health Survey (PNS), which reached 6.7% of obesity among Brazilian adolescents in 2019 (Brazil, 2020). This discrepancy may reflect methodological differences, such as the specific age group or the regional context, but it may also indicate a worsening of the problem among adolescents in the public school system of the state of Pernambuco.

In line with the literature, obesity indicators have increased worldwide in recent years, especially in low- and middle-income countries (Phelps et al., 2024). Furthermore, global estimates suggest that by 2035, 39% of children and adolescents up to 19 years old will be overweight or obese (Lobstein et al., 2024). This information may be related to the increasing prevalence of physical inactivity and preferences for sedentary behaviors among young people (Abarca-Gómez et al., 2017; Phelps et al., 2024).

The prevalence of adolescents meeting the recommendations was similar to that found in other studies. Approximately 27.7% of participants met the recommendation for Moderate-to-Vigorous Physical Activity (MVPA), a value similar to that found in Canadian adolescents (Janssen; Roberts; Thompson, 2017) and North American adolescents (Katzmarzyk; Staiano, 2017), but higher than that reported in studies with Chinese adolescents (Chen et al., 2021; Shi et al., 2020). This difference may be related to contextual, cultural, and methodological variables, such as the use of different measurement instruments, or the influence of regional socioeconomic factors. Regarding ST, 28.5% of adolescents reported using TV, computer, video games, and smartphone or tablet, on average, up to two hours per day, as observed in other studies (Jakubec et al., 2020; Katzmarzyk & Staiano, 2017; Shi et al., 2020).

The prevalence of adolescents sleeping 8 to 10 hours per day was 26.5% in our sample. The literature indicates that a large part of adolescents presents similar levels of meeting the sleep recommendation; however, lower values were identified in other studies with adolescents (Carson et al., 2017; Zhu et al., 2020) and higher values (Chen et al., 2021; Yang et al., 2022), presenting variations in different contexts.



Based on this, we identified a high prevalence of insufficient sleep in adolescents, especially on school days, and this problem worsens with increasing age, marked by the transition of adolescents from elementary to high school (Mitchell et al., 2020).

The association of isolated behaviors has been analyzed in other studies, and our results are in line with previous studies that highlighted the importance of high MVPA and reduced ST for adolescent health, but observed only among boys. These findings may be related to sex differences, related to physiological, behavioral and social aspects. Adolescents who do not meet the MVPA recommendations, or physically inactive adolescents, have higher chances of being obese (Van Sluijs et al., 2021), and developing a series of associated diseases (Jiménez Boraita et al., 2022; Kunzle-Elizeche et al., 2018). While also being sedentary, further aggravating the health risk condition. Excessive ST, mainly screen-based, has also been associated with higher chances of obesity in adolescents (Van Sluijs et al., 2021). Girls, although they have a higher prevalence of excess weight, may be exposed to other risk factors not assessed in this study, such as inadequate dietary patterns, which may explain the lack of a significant association with the behaviors analyzed.

However, it is important to recognize the limitations of the present study. A causal association cannot be established because the study is cross-sectional. Another point relates to the self-reported nature of the data, which may have been influenced by memory bias, as the exposure time to behaviors may have been underestimated or overestimated by adolescents. However, the main strength of our study is the sample size, which involves a large number of high school adolescents from the state of Pernambuco, enabling better direction and understanding for future actions and strategies for behavior change, as it describes a high prevalence of excess weight in adolescents.

## Conclusions

This study analyzed the relationship between adherence to physical activity, screen time, and sleep recommendations with excess weight in high school adolescents in Pernambuco, Brazil. The results indicate that a low proportion of adolescents meet these recommendations, and that boys who do not meet recommendations to physical activity and screen time them are more likely to be obese. No significant associations were observed in girls, although girls have a higher prevalence of excess weight, so it is important that further studies explore these differences in more depth, as they may be related to other factors not analyzed. And in total sample, boys and girls who do not meet recommendations to screen time them are more likely to be obese.

These findings highlight the need to implement public health strategies that promote physical activity, reduce screen time, and ensure adequate sleep duration among adolescents. Although the study analyzed behaviors in isolation, the results reinforce the importance of considering multiple factors in addressing adolescent excess weight.

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