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Artigo Original

Association between physical activity and sleep indicators among adolescents: a cross-sectional study

Associação entre atividade física e indicadores de sono em adolescentes: um estudo transversal

Asociación entre actividad física e indicadores de sueño en adolescentes: un estudio transversal

Diogo Henrique Constantino Coledam¹ 

Alessandro Hervaldo Nicolai Ré² 

ABSTRACT

Purpose: The aim of the present study is to analyze the association between physical activity and sleep indicators among adolescents. **Methods:** Cross-sectional study involving 647 adolescents (53.0% female). Leisure time physical activity at low and at moderate to vigorous intensities (420 min/week) were the independent variables and the outcomes were daytime sleepiness, classroom sleepiness, poor sleep perception, sleep duration, bedtime, and wake up time. The multivariate association was performed by Poisson regression to estimate Prevalence Ratios (PR). **Results:** Not achieving 420 min/week of physical activity at light and at moderate to vigorous intensities was associated with a higher prevalence ratio for classroom sleepiness (PR=1.79 and 1.64), daytime sleepiness (PR=1.25 and 1.17), and poor sleep perception (PR=1.52 and 1.27), all $P < 0.05$. However, not achieving 420 min/week showed the opposite association and decreased the prevalence ratio for having a sleep duration $< 8h$ (PR=0.74 and 0.72), $P < 0.05$. No association was found between physical activity and bedtime or wake up time. Mediation analysis revealed that the association between physical activity and daytime sleepiness was fully mediated by a poor perception of sleep quality, while classroom sleepiness showed a partial mediation. **Conclusion:** Physical activity seems to have a positive effect on daytime sleepiness, classroom sleepiness, and perceived sleep quality. Poor sleep perception was the pathway through which physical activity was associated to sleepiness in the present sample. Conversely, physical activity reduced the likelihood of students achieving 8h of sleep.

Keywords: Mediation Analysis. Motor Activity. Sleepiness. Sleep Quality. Sleep Hygiene.

RESUMO

¹ Universidade de São Paulo, Escola de Artes, Ciências e Humanidades, São Paulo-SP, Brasil.

² Universidade de São Paulo, Escola de Artes, Ciências e Humanidades da Universidade de São Paulo, Departamento de Educação Física e Saúde, São Paulo-SP, Brasil.

Correspondência:

Diogo Henrique Constantino Coledam. Av. Arlindo Béttio, 1000, Ermelino Matarazzo, CEP 03828-000. Email: diogohcc@yahoo.com.br



Objetivo: O objetivo do presente estudo é analisar a associação entre atividade física e indicadores de sono em adolescentes. **Metodologia:** Estudo transversal envolvendo 647 adolescentes. A atividade física no tempo livre nas intensidades leve e moderada a vigorosa (420 min/semana) foram as variáveis independentes e os desfechos foram: sonolência diurna, sonolência em sala de aula, percepção de sono ruim, duração do sono, hora em que se deita e acorda. A associação multivariada foi realizada por meio da regressão de Poisson para estimar as Razões de prevalência (PR). **Resultados:** Não atingir 420 min/semana de atividade física leve e moderada a vigorosa se associou com a maior razão de prevalência de sonolência em sala de aula (PR=1,79 e 1,64), sonolência diurna (PR=1,25 e 1,17) e percepção de sono ruim (PR=1,52 e 1,27), $P < 0,05$. No entanto, não atingir 420 min/semana demonstrou associação oposta e reduziu a razão de prevalência para duração de sono $< 8h$ (PR=0,74 e 0,72), $P < 0,05$. Nenhuma associação foi encontrada entre atividade física e hora de deitar ou acordar. A associação entre atividade física e sonolência diurna foi mediada de forma completa pela percepção de sono ruim, enquanto que a sonolência em sala de aula foi mediada parcialmente. **Conclusão:** A atividade física parece ter efeito positivo na sonolência diurna, em sala de aula e na percepção de sono. A percepção de sono foi a via pela qual a atividade física associou-se à sonolência na amostra estudada. Por outro lado, a atividade física reduziu a probabilidade de estudantes atingirem 8h de sono.

Palavras-chave: Análise de mediação. Atividade motora. Sonolência. Qualidade do sono. Higiene do sono.

RESUMEN

Objetivos: El objetivo del presente estudio es analizar la asociación entre actividad física e indicadores de sueño en adolescentes. **Metodología:** Estudio transversal en el que participaron 647 adolescentes. La actividad física en el tiempo libre a intensidades ligera y moderada a vigorosa (420 min/semana) fueron las variables independientes y las dependientes fueron: somnolencia diurna, somnolencia en el aula, mala percepción del sueño, duración del sueño, hora de acostarse y despertarse. La asociación multivariada se realizó mediante regresión de Poisson para estimar las razones de prevalencia (RP). **Resultados:** No alcanzar 420 min/semana de actividad física ligera y moderada a vigorosa se asoció con una mayor razón de prevalencia de somnolencia en el aula (RP=1,79 y 1,64), somnolencia diurna (RP=1,25 y 1,17) y mala percepción del sueño. (RP=1,52 y 1,27), $P < 0,05$. No alcanzar los 420 min/semana demostró la asociación opuesta y redujo la razón de prevalencia para la duración del sueño $< 8 h$ (RP = 0,74 y 0,72), $P < 0,05$. No se encontró asociación entre la actividad física y la hora de acostarse o despertarse. La asociación entre actividad física y somnolencia diurna fue completamente mediada por la mala percepción del sueño, mientras que la somnolencia en el aula fue parcialmente mediada. **Conclusión:** La actividad física parece tener un efecto positivo sobre la somnolencia diurna, en el aula y sobre la percepción del sueño. La percepción del sueño es la forma en que la actividad física redujo la somnolencia en la muestra estudiada. Por otro lado, la actividad física redujo la probabilidad de que los estudiantes alcanzaran las 8 horas de sueño.

Palabras Clave: Análisis de Mediación. Actividad Motora. Somnolencia. Calidad del Sueño. Higiene del Sueño.

INTRODUCTION

Sleep disorders are defined as conditions characterized by disturbances in usual sleep patterns or behaviors, that cause distress and impair daytime functioning (SIE, 2013). Although several classifications exist, general sleep disorders are highly prevalent in children and adolescents and significantly affect their physical, neurocognitive, emotional, and behavioral development (HEIN *et al.*, 2020; KANSAGRA, 2020; TROSMAN; IVANENKO, 2020). Another impairment caused by poor sleep hygiene is excessive daytime sleepiness. This is a major public health problem in adolescents due to the negative consequences, such as an impact on academic school performance, risk of accidents, decrease in extracurricular activities, and negative consequences in terms of somatic and other physical, metabolic, social, and psychological risks (HEIN *et al.*, 2020; KANSAGRA, 2020). There is a consensus that for good health, adolescents need to achieve between 8 and 10 hours of sleep daily (PARUTHI *et al.*, 2016).

The severe consequences of exposure to chronic sleep disorders have increased interest in investigating risk factors for adolescent sleep patterns. In addition to specific disorders that affect sleep among adolescents (TROSMAN; IVANENKO, 2020), other factors, such as a negative home environment, inadequate sleep hygiene, tobacco, screen time, noise, inconsistent night and sleep routines, evening light, and caffeine use negatively impact adolescents' sleep patterns (BARTEL *et al.*, 2015; KANSAGRA, 2020). Among non-pharmacological variables that demonstrate the potential to improve the sleep patterns of adolescents, physical activity has been highlighted in the literature. Physical activity seems to improve sleep duration (GANZ *et al.*, 2022; MASTER *et al.*, 2019), perception of sleep quality (LANG *et al.*, 2013), earlier sleep onset (MASTER *et al.*, 2019), sleep maintenance efficiency (Master *et al.*, 2019), and insomnia (SANTOS *et al.*, 2021), as well as reducing excessive daytime sleepiness (ISA *et al.*, 2019; MALHEIROS *et al.*, 2021).

Despite the high number of studies, some aspects of the association between physical activity and sleep indicators among adolescents have not yet been fully clarified. First, the association between physical activity and sleep among adolescents is not a consensus in the literature, since some studies demonstrated no association (BARBOSA *et al.*, 2020; FELDEN *et al.*, 2016a; MEYER *et al.*, 2019; OLIVEIRA *et al.*, 2018; SOUSA NETO *et al.*, 2020) or a poor sleep profile among those with higher physical activity levels (CASTIGLIONE-FONTANELLAZ *et al.*, 2022). Second, the role of physical activity intensity in these associations is still poorly understood, which has already been described for mental health (COLEDAM *et al.*, 2023). Third, when describing a significant association between physical activity and daytime sleepiness, studies did not assess if there is another sleep variable that could mediate the

association (ISA *et al.*, 2019; MALHEIROS *et al.*, 2021), and this information could improve knowledge regarding the pathway through which physical activity can improve the sleep outcome or if the association is independent.

Therefore, the aim of the present study is to analyze the association between physical activity at different intensities and sleep indicators among adolescents.

METHODS

PARTICIPANTS

This is a cross-sectional study, which forms part of a project entitled "Health risks among adolescents: association with the type of course in high school," conducted in 2019 in Boituva City, São Paulo, Brazil. In 2019, the city had a population of 62,170 inhabitants and a target population of 2460 adolescents in three public high schools. All schools were invited and two agreed to participate in this study. The sample size was calculated using the software Open Epi, OpenEpi Project (Atlanta, U.S.A.), version 3.01, taking into account the following parameters: N = 2460, prevalence of 50%, precision of 5%, design effect of 1.5, and confidence interval of 95%. The prevalence of 50% was used to ensure the largest sample size (n=499) to enable estimation of different outcomes. Data collection was conducted with 675 adolescents. The inclusion criteria were being between 14 and 18 years of age, being enrolled in a public high school, and not presenting any cognitive limitation that prevented completion of the questionnaire.

PROCEDURES

The present study was approved by the Research Ethics Committee of the Federal Institute of Education, Science and Technology of São Paulo, protocol 06438418.1.0000.5473. All participants and parents signed a consent and assent form before participating in the study. All procedures were carried out in the school where the participants were enrolled. Initially the schools were visited to present the project to the principals and schedule a visit to present the project and invite the participants. After the return of the consent and assent forms, data collection was scheduled and performed in each school. All variables were collected using a self-report questionnaire and the completion time was approximately 30 minutes.

VARIABLES AND INSTRUMENTS

The independent variables of the present study were physical activity at low and at moderate to vigorous intensities. Physical activity was assessed

using the Brazilian version of the international physical activity questionnaire (MATSUDO *et al.*, 2001). Only leisure time physical activity was analyzed, at low and at moderate to vigorous intensities (COLEDAM *et al.*, 2023). The cut-off for physical activity volume was 420min/week (BULL *et al.*, 2020).

The following sleep indicators were the dependent variables of the study: Daytime sleepiness, classroom sleepiness, poor sleep perception, sleep duration, bedtime, and wake up time. Daytime sleepiness was assessed by the Brazilian version of the Pediatric daytime sleepiness scale (FELDEN *et al.*, 2016b). The instrument contains eight questions related to sleepiness in different situations of the day, each item scored on a 5-point Likert scale. A score of 15 points was adopted, as proposed previously (MEYER *et al.*, 2017). Classroom sleepiness was assessed by a question on Pediatric daytime sleepiness: "How often do you fall asleep or get drowsy during class periods?" (FELDEN *et al.*, 2016b). Poor sleep perception was assessed by the question "How do you rate the quality of your sleep?", with the following response options: "great", "very good", "good", "regular", and "poor". Regular and poor were clustered as poor sleep quality perception. Bedtime and wake up time were assessed by an open question. Sleep duration was calculated using bedtime and wake up time on the weekend and the cut-off adopted was 8h (PARUTHI *et al.*, 2016). For statistical analysis purposes, bedtime was expressed as discrete variables representing the number of hours after 8 pm and wake up time was expressed as the number of hours after 6 am.

The covariates of this study were sex, age, high school course, work status, and socioeconomic status. Participants informed their sex in a question with two responses "male" or "female". Age was calculated using the difference between the informed date of birth and the date of data collection. Participants informed the type of high school course in which that were enrolled (COLEDAM *et al.*, 2022): "vocational course (full time)" or "general high school (half-time)". Socioeconomic status was assessed by the level of education of the household head, using the questionnaire of the Brazilian Market Research Association (ABEP, 2018). Work status was assessed by the question "Do you work formally or informally in the period of the day when you are not studying?" with answer options "yes" or "no" (COLEDAM *et al.*, 2022).

STATISTICAL ANALYSIS

Descriptive analysis was conducted by relative frequency for most variables, except bedtime and wake up time, which were described by median and interquartile ranges of 25 and 75%. The independent variables were physical activity in low and moderate to vigorous intensities. Daytime sleepiness, classroom sleepiness, poor sleep perception, sleep duration, bedtime, and wake up time were dependent variables and the covariates used to adjust analysis were sex, age, high school course, work status, and

socioeconomic status. Bivariate associations between physical activity and sleep indicators were performed by the Pearson Chi-Square test and Mann-Whitney test. Multivariate analysis was performed using Poisson regression to estimate the prevalence ratios (PR) and confidence intervals of 95% (CI95%), considering sample weight, strata (sex), and primary sample units (schools) using the command survey "svy" of STATA 14.0. Further regression analysis was performed to test the single mediation in the association between physical activity and daytime and classroom sleepiness. The following procedures were performed to analyze the mediation: test if the independent variable (physical activity) was significantly associated with the outcome (sleepiness); test if the independent variable is significantly associated with the mediator (poor sleep perception); test the inclusion of the independent variable and the mediator simultaneously in the same model. If the independent variable is associated with the outcome and the mediator, and the mediator is also associated with the outcome, the mediation can be tested. To confirm the mediation, two criteria were adopted: 1) Complete mediation, when the inclusion of the mediator in the model results in loss of statistical significance of the association between the independent variable and outcome; 2) Partial mediation, when the inclusion of the mediator reduces the magnitude of the association between the independent variable and outcome.

RESULTS AND DISCUSSION

Data collection was performed with 675 participants and the final sample was composed of 647 participants, mainly due to unanswered questions. The included participants presented the following sociodemographic characteristics: female (53.0%), high school part time (68.5%), 15 to 16 years old (31.2%), no work (71.3%), and household head with completed high school (35.1%). With regard to sleep variables, most of the participants reported excessive daytime sleepiness (68.0%) and classroom sleepiness (68.4%), a sleep duration higher than 8h (54.6%), and good sleep perception (51.2%). The prevalence values of 420 min/week of physical activity at light and at moderate to vigorous intensities were 10.7 and 21.8% respectively.

Table 1 describes the bivariate associations between physical activity and the analyzed sleep indicators. Physical activity at both low and at moderate to vigorous intensity was associated with a lower prevalence of classroom sleepiness, daytime sleepiness, and poor sleep perception, all $P < 0.05$. Physical activity at both low and at moderate to vigorous intensity was associated with a higher prevalence of sleep duration $< 8h$, and with later bedtime (< 0.05), while no association was found for wake up time.

Table 1. Bivariate associations between physical activity and sleep indicators

	Classroom sleepiness		Daytime sleepiness	
	%	PR (CI95%)	%	PR (CI95%)
LPA	P=0.012		P<0.001	
No	32.9	1.45 (1.09 - 1.93)	69.7	1.20 (0.99 - 1.45)
Yes	18.3	1.00	47.8	1.00
MVPA	P=0.001		P<0.001	
No	34.5	1.72 (1.17 - 2.55)	72.1	1.42 (1.10 - 1.82)
Yes	20.0	1.00	50.7	1.00
	Poor sleep perception		Sleep duration <8h	
	%	PR (CI95%)	%	PR (CI95%)
LPA	P=0.003		P=0.013	
No	50.4	1.58 (1.03 - 2.41)	44.3	0.74 (0.53 - 1.03)
Yes	31.9	1.00	59.7	1.00
MVPA	P=0.008		P=0.002	
No	51.1	1.31 (0.99 - 1.75)	42.8	0.75 (0.58 - 0.96)
Yes	38.8	1.00	57.1	1.00
	Bedtime ¹		Wake up time ²	
	Mean (IR)	RR (CI95%)	Mean (IR)	RR (CI95%)
LPA	P=0.017		P=0.387	
No	3.00 (2.00-4.00)	0.87 (0.78 - 0.96)	1.00 (1.00-3.00)	0.88 (0.69-1.11)
Yes	4.00 (3.00-4.00)	1.00	1.00 (1.00-3.00)	1.00
MVPA	P=0.012		P=0.746	
No	3.00 (2.00-4.00)	0.86 (0.80-0.94)	1.00 (1.00-3.00)	0.89 (0.73-1.07)
Yes	4.00 (3.00-5.00)	1.00	1.00 (0.50-3.00)	1.00

% - Relative frequency; PR - Prevalence ratio; IR - Interquartile range; RR - Rate ratio; LPA - Low intensity physical activity 420 min/week; MVPA - Moderate to vigorous physical activity 420 min/week; ¹Expressed as number of hours after 8 pm; ² - Expressed as number of hours after 6 am.

The multivariate associations between physical activity and sleep indicators are described in Table 2. The associations found in the bivariate analysis remained significant when adjusted for control variables. Not achieving 420 min/week of physical activity at light and at moderate to vigorous intensities was associated with higher prevalence ratios for classroom sleepiness (PR=1.79 and 1.64), daytime sleepiness (PR=1.25 and 1.17), and poor sleep perception (PR=1.52 and 1.27), all P<0.05. However, adolescents who do not not achieve

420 min/week of physical activity were less likely for having a sleep duration <8h (0.74 and 0.72) compared to the active ones, indicating a possible deleterious effect of physical activity on sleep duration. No associations were found between physical activity and bedtime or wake up time.

Table 2. Multivariate associations between physical activity and sleep indicators

	Classroom sleepiness ¹ PR (CI95%)	Daytime sleepiness ¹ PR (CI95%)
LPA		
No	1.79 (1.09-2.97)	1.25 (1.01-1.55)
Yes	1.00	1.00
MVPA		
No	1.64 (1.12-2.42)	1.17 (1.00-1.37)
Yes	1.00	1.00
<hr/>		
	Poor sleep perception ¹ PR (CI95%)	Sleep duration <8h ² PR (CI95%)
LPA		
No	1.52 (1.05-2.18)	0.74 (0.59-0.93)
Yes	1.00	1.00
MVPA		
No	1.27 (1.00-1.59)	0.72 (0.59-0.86)
Yes	1.00	1.00
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	Bedtime ² RR (CI95%)	Wake up time ² RR (CI95%)
LPA		
No	0.94 (0.85-1.04)	1.05 (0.84-1.32)
Yes	1.00	1.00
MVPA		
No	0.96 (0.88-1.04)	1.04 (0.86-1.25)
Yes	1.00	1.00

PR - Prevalence ratio; LPA - Low intensity physical activity 420 min/week; MVPA - Moderate to vigorous physical activity 420 min/week; 1 - Adjusted for sex, age, high school course, work status, socioeconomic status, and sleep 8h; 2- Adjusted for sex, age, high school course, work status, and socioeconomic status. Bold denotes significance at P<0.05.

Complementary analyses were performed to test if poor sleeping perception mediates the association between physical activity at low and at moderate to vigorous intensities with excessive daytime sleepiness and classroom sleepiness. When the variable poor sleep perception was included in the same multivariate models, the associations between low intensity physical

activity (PR= 1.25, 1.01-1.55 vs 1.20, 0.96-1.48) and moderate to vigorous physical activity (PR=1.17, 1.00-1.37 vs 1.13, 0.97-1.32) with daytime sleepiness became non-significant, indicating a complete mediation. The associations found for classroom sleepiness remained significant after the inclusion of poor sleep perception in the models of low intensity physical activity (PR=1.79, 1.09-2.97 vs 1.66, 1.02-2.68) and moderate to vigorous physical activity (PR=1.64, 1.12-2.42 vs 1.55, 1.23-2.02), but the effect of the associations decreased, indicating a partial mediation.

In the literature, the association between physical activity and daytime sleepiness is controversial; while there is information describing low daytime sleepiness among active adolescents (ISA *et al.*, 2019; MALHEIROS *et al.*, 2021;), other studies demonstrated no association (ALVES *et al.*, 2020; BARBOSA *et al.*, 2020; MEYER *et al.*, 2019). In the present study, physical activity <420min/week was associated with daytime and classroom sleepiness, independent of intensity. However, different from previous studies, we performed a mediation analysis to investigate the mechanism that explains the associations. When the variable poor sleep perception was inserted into the models, the associations between physical activity and daytime sleepiness became non-significant and the magnitude decreased for classroom sleepiness. These results demonstrated that, in the present sample, physical activity did not have a direct effect on daytime sleepiness, which was mediated by perceived sleep perception, implying an indirect relationship.

With regard to sleep perception, the results demonstrated that active adolescents have a better perception of sleep compared to non-active adolescents, which is in line with a previous study (LANG *et al.*, 2013). Another study demonstrated that physical exercise, but not physical activity, was not associated with perceived sleep quality (OLIVEIRA *et al.*, 2018). Despite differences in definitions between variables, in the present study physical activity and physical exercise were considered as the same variable according to the questionnaire used, and the results corroborate in part those presented by Oliveira *et al.* (2018). Furthermore, in the present study it was found that perception of sleep quality fully mediated the association between physical activity and daytime sleepiness and partially mediated the association with classroom sleepiness. These results improved the current knowledge, indicating that physical activity provides benefits to perceived sleep quality and can positively affect daytime sleepiness.

Surprisingly, physical activity both at low and moderate to vigorous intensities was negatively associated with sleep duration <8h. It should be considered that the cut-off considered for physical activity was 420 min/week, as recommended by the World Health Organization (BULL *et al.*, 2020) and adopted in epidemiological studies (COLEDAM *et al.*, 2023). Some aspects can explain these associations. Different from other outcomes, sleep duration is influenced

by the routine of the adolescents which, in addition to their high school course, includes domestic tasks, extracurricular activities, transportation, work, school homework, socializing, and school start time (COLEDAM *et al.*, 2022; HOYT *et al.*, 2018), and these barriers prevent the achievement of the recommended duration of sleep. Considering the high recommended volume of physical activity, this can also represent an additional barrier to sleep duration among adolescents, but not by modifying bedtime or wake up time. The absence of association between physical activity and bedtime and wake up time may be due to an inaccuracy of this self-report measure in estimating real sleep onset and offset. Another possible reason could be the time when students perform physical activities, since it is known that physical activities mainly in vigorous intensity should not be performed too close to sleep time (HEIN *et al.*, 2020). Due to a full day of tasks, some adolescents may include physical activity during the night period.

Several physiological effects of physical activity and exercise on sleep have been described, that include multiple pathways, such as circadian rhythm, metabolic, immune, thermoregulatory, vascular, mood, and endocrine effects (CHENNAOUI *et al.*, 2015). In fact, the associations with physical activity are complex, which cannot be explained by an isolated mechanism, and can present a reciprocal relationship with specific pathways that result in a reduction in physical performance (CHENNAOUI *et al.*, 2015). Although some experimental studies demonstrate the beneficial effects of physical activity on some sleep outcomes (BELLO *et al.*, 2023), the bidirectional effect between these variables has also been demonstrated (MASTER *et al.*, 2019). In view of the wide range of health benefits provided by physical activity and sleep, both behaviors should be monitored among young people, to ensure healthy human development.

This is an exploratory observational study and it is important to mention that sleep behavior is influenced by a variety of other variables related to insufficient or fragmented sleep, as well as increased sleep need (HEIN, 2020), that were not included in the analysis and should be considered in future studies. Among the behavioral and environmental aspects, those related to poor sleep hygiene were highlighted and include nighttime routine schedule, cool sleep environment, environment free from noise and light. Furthermore, avoid any screen time before bed and reduce number of electronic media devices in bedroom are also relevant aspects to be considered (KANSAGRA, 2020). Other relevant causes of poor sleep were insomnia, circadian rhythm disorders, use of stimulants or drugs, respiratory, movement and neurological disorders, somatic pathologies and hypersomnia (HEIN, 2020; KANSAGRA, 2020). The sample of this study was composed by adolescents, which is a phase of drastic physical, psychological and social modifications. The exhaustive routine of studies, exams, work, and concerns about decisions that will impact the future can lead to common mental disorders development, that also impairs sleep quality and consequently increase daytime sleepiness (COLEDAM *et al.*, 2022).

The present results should be interpreted considering some limitations. The cross-sectional design prevents understanding of the causality of the associations and reverse causality cannot be disregarded. The borderline confidence intervals found for some associations also represents a limitation because this can result in misinterpretation as to whether a mediation is partial or complete. Another limitation is that all variables analyzed were self-reported, which could present recall bias and less precision compared to direct measures of physical activity and sleep. To reduce bias, most of the instruments adopted were previously validated and tested in adolescents. The lack of a variable considering the time at which participants performed physical activity, summed to other variables related to sleep hygiene and chronotype are another limitation. The multivariate analysis adjusted for potential confounders, mediation analysis and outcomes with high relevance for adolescent health are the strengths of the present study.

FINAL CONSIDERATIONS

In the sample of adolescents analyzed, not achieving physical activity recommendation (420 min/week), both at low and at moderate to vigorous intensities is associated with daytime sleepiness, classroom sleepiness, and poor sleep perception. Conversely, not achieving 420 min/week of physical activity reduce the likelihood of having insufficient sleep duration the day. The variable poor sleep perception fully mediates the association between physical activity and daytime sleepiness and partially mediates the association with classroom sleepiness. No association were found between physical activity and bedtime and wake up time.

NOTES

CONFLICT OF INTEREST

Authors have no conflicts of interest, including specific financial interests and relationships and affiliations relevant to the topic or materials discussed in the manuscript.

AUTORSHIP

The authors declare that they participated significantly in the construction and training of this study, having, as author, public responsibility for its content, as they contributed directly to the intellectual content of this work and satisfy the authorship requirements.

Diogo Henrique Constantino Coledam - Conception and development (since the idea to the investigation or article, created the hypotheses); Methodological design (planning of the methods to generate the results); Supervision (responsible for the

organization and execution of the project and the writing of the manuscript); Collection and treatment of the data (responsible for the experiments, patients, data organization); Analysis/interpretation (responsible for the statistical analysis, evaluation, and presentation of the results); Literature survey (participated in the bibliographical research and the article survey); Redaction (responsible for writing a substantial part of the manuscript); Critic review (responsible for the review of the intellectual content of the manuscript before the final presentation).

Alessandro Hervaldo Nicolai Ré - Supervision (responsible for the organization and execution of the project and the writing of the manuscript); Analysis/interpretation (responsible for the statistical analysis, evaluation, and presentation of the results); Literature survey (participated in the bibliographical research and the article survey); Redaction (responsible for writing a substantial part of the manuscript); Critic review (responsible for the review of the intellectual content of the manuscript before the final presentation).

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