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## Original article

### 24-Hour Movement Guidelines: Descriptive Study with Overweight and Obese Low-Income Children

Pautas de movimiento de 24 horas: estudio descriptivo con niños y niñas de bajos ingresos con sobrepeso y obesidad

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#### Abstract

**Objective:** This study aimed to examine the prevalence of meeting the 24-Hour Movement Guidelines among overweight and obese (OW/OB) children from low-income conditions and compare this prevalence by gender, age, and body mass index (BMI) classification. **Methods:** Accelerometer-based physical activity (PA), self-report sleep duration (SD), and screen time (ST) were analyzed in 72 OW/OB eight to 12 years old children (21 girls) from low-income conditions. **Results:** None of the participants met the recommendations for all three behaviors, and only 9.3% met for two behaviors simultaneously. Recommendations for PA, SD, and ST were met for 18.5%, 51.5%, and 4.9% of children, respectively. The prevalence of meeting the recommendation for SD was higher ( $p=.027$ ) in younger participants ( $\leq 10$  years old, 65.7%) than for the older ones ( $>10$  years old, 37.5%). **Conclusion:** None of OW/OB low-income children met the 24-Hour Movement Guidelines. These results appoint for the urgent attention of health and education professionals in order to include opportunities for PA practice and knowledge about sleep and sedentary behaviors in future interventions.

**Keywords:** child; physical activity; sleep; screen time; socioeconomic status

#### Resumen

**Objetivo:** Este estudio tuvo como objetivo examinar la prevalencia de cumplir con las Pautas de movimiento de 24 horas entre niños y niñas con sobrepeso y obesos (SP/OB) de condiciones de bajos ingresos y comparar esta prevalencia por género, edad y clasificación del índice de masa corporal (IMC). **Métodos:** Se analizó la actividad física (AF) basada en el acelerómetro, la duración del sueño (DS) y el tiempo de pantalla (TP) en 72 niños con SP/OB de ocho a 12 años (21 niñas) pertenecientes a familias de bajos ingresos. **Resultados:** Ninguno de los participantes cumplió con las recomendaciones para los tres comportamientos, y solo el 9,3% cumplió para dos comportamientos simultáneamente. Las recomendaciones para AF, DS y TP se cumplieron en el 18,5 %, 51,5 % y 4,9 % de los niños, respectivamente. La prevalencia de cumplimiento de la recomendación de DS fue mayor ( $p=0,027$ ) en los participantes más jóvenes ( $\leq 10$  años, 65,7%) que en los mayores ( $>10$  años, 37,5%). **Conclusión:** Ninguno de los niños con SP/OB de bajos ingresos cumplió con las Pautas de movimiento de 24 horas. Estos resultados apuntan a la atención urgente de los profesionales de la salud y la educación con el objetivo de generar futuras intervenciones que incluyan oportunidades para la práctica de AF y educación sobre el sueño y las conductas sedentarias.

**Palabras llave:** niños; actividad física; dormir; tiempo de pantalla; nivel socioeconómico

## Key points

- Overweight and obese low-income children do not meet the 24-Hour Movement Guidelines for all three behaviors (physical activity, sedentary behavior, and sleep duration) simultaneously.
- Screen time (sedentary behavior) is the behavior with the lowest proportion of compliance with recommendations.
- There is no difference in compliance with recommendations by gender and body mass index classification (overweight and obese).
- The proportion of younger participants ( $\leq 10$  years old) who meet the recommendation for sleep duration is higher than for the older ones ( $> 10$  years old).

## Introduction

Children and adolescents who meet the recommendations for physical activity (PA)<sup>1</sup>, sedentary behavior, mainly relative to recreational screen time (ST)<sup>2</sup>, and sleep duration (SD)<sup>3</sup> show better health profiles than those who do not meet. Although these three behaviors associate independently with several health outcomes in children and adolescents<sup>1-3</sup>, collectively, they integrate the 24 hours of the day<sup>4</sup>. Thus, changes in the involvement time in one of them modify, at least, the involvement time in the other. This interaction among the three behaviors has been considered 24-Hour Movement<sup>4</sup>, and it has aroused interest in the study of the combination of these behaviors in the health markers of children and adolescents.

Studies<sup>5-10</sup> performed in different parts of the world combining PA, ST, and SD of children and adolescents have considered the Canadian 24-Hour Movement Guidelines<sup>4</sup>. Such Guidelines provide recommendations for the daily time in moderate to vigorous PA (MVPA), recreational ST, and SD. Results of these studies<sup>5-10</sup> showed a very low prevalence of children and adolescents meeting the 24-Hour Movement Guidelines for the three behaviors simultaneously. In Brazil, a recent study<sup>9</sup> showed that only 3% and 0.2% of adolescents met the Guidelines for the three behaviors simultaneously when the MVPA and SD were assessed by self-report and accelerometry, respectively. There is a trend of improvement in the health profile as adolescents meet one, two, and all three behaviors compared to those who do not meet any<sup>2,5,7</sup>. Following this, the results about the prevalence of the meeting of the 24-Hour Movement Guidelines are worrying. In this sense, public health policies and effective intervention programs should be developed to increase the daily time of MVPA, reduce the time with recreational ST, and provide adequate SD for children and adolescents. The planning and development of these actions should count specific features of the population in which the interventions will be performed.

Previous studies have demonstrated that overweight and obese (OW/OB) children and adolescents are less likely to meet 24-Hour Movement Guidelines than those who are eutrophic<sup>5,8</sup>. Another important feature associated with non-compliance with 24-Hour Movement Guidelines among children and adolescents is the income conditions<sup>9</sup>. Young individuals from low-income conditions have less opportunity to practice leisure PA, spend more time in recreational ST, and have less SD than high-income conditions<sup>10-13</sup>. Besides, a recent meta-analysis showed that compliance to 24-Hour Movement Guidelines is lower among girls than boys and decreases from childhood to adolescence<sup>14</sup>. Nevertheless, there is a lack of information if the differences in the compliance to 24-Hour Movement Guidelines between genders and age advancing remain when analyzing OW/OB children from low-income conditions. Studies analyzing these issues may provide decisive information for planning and carrying out interventions to improve health-related behaviors in this population subgroup. This study aimed to examine the prevalence of meeting the 24-Hour Movement Guidelines among OW/OB children from low-income conditions and compare this prevalence by gender, age, and body mass index (BMI) classification.



## Methods

This cross-sectional study was performed using baseline data of 72 overweight, obese, and severe obese children who have made part of the Sport and Health for Overweight Children (SHOW), a non-randomized clinical trial study. The general aim of the SHOW study was to examine the effects of a multicomponent intervention program on different health markers in OW/OB children from low-income conditions in Pelotas, Brazil. The SHOW study was approved by an Ethics Committee (protocol number: 4.127.321 / CAAE: 15719119.2.0000.5313), and its protocol was described in detail<sup>15</sup>.

The participant recruitment was carried out after a partnership between Municipal Education and Sport (MESD) and Municipal Health (MHD) Departments and the research team. Representatives of MESD would like to develop structured sports and PA programs for children and adolescents from a social vulnerability neighborhood where a Public Square had recently been built. Important to highlight that this neighborhood's history is marked by conflicts and occupations of lots that contributed to generating a serious lack of urban infrastructure for its inhabitants. In addition, the neighborhood is characterized by street violence, drug trafficking, problems with basic sanitation and accumulation of garbage in the streets, lack of public spaces for leisure, and insufficient places in schools for all children, among other social problems<sup>16</sup>. MHD representatives showed that intervention programs were made initially for OW/OB schoolchildren. Thus, MESD and MHD representatives and the research team defined that an intervention involving sports practice, health education, and the parents' participation for OW/OB schoolchildren aged eight to 12 years old would be the first structured program performed at the new Public Square of the neighborhood.

A survey of the nutritional status of schoolchildren from the two Municipal Public Schools around the Public Square was carried out, and parents of all children aged eight to 12 years old classified as overweight, obese, or severe obese were contacted to present the characteristics of the SHOW study. After these steps, 35 children composed the intervention group. For the composition of the control group, a survey of the nutritional status of schoolchildren of another Municipal Public School located in a neighborhood with similar sociocultural features was carried out. Parents of all children aged eight to 12 years old classified as overweight, obese, or severe obese were contacted to present the characteristics of the SHOW study. Explanation about the characteristics of a control group and to inform that after the intervention period, an afterschool program with the same characteristics of the SHOW study would be offered for OW/OB schoolchildren. A total of 37 children composed the control group. The option for selecting children enrolled in a school located in another neighborhood with similar sociocultural features to compose the control group was taken, aiming to reduce the vies of contamination and conserve similar sociocultural characteristics. Thus, 72 children (70.8% male) aged eight to 12 ( $10.23 \pm 1.27$  years) participated in the SHOW study baseline.

Participants of the present study were characterized according to gender (male/female), age (centesimal age – data collected and birthday difference), familiar income (assessed by parents' report of family monthly minimum wages), and nutritional status (overweight, obesity and severe obesity - considered through the body mass index -BMI- classification)<sup>17</sup>. For calculating BMI, height and weight were measured according to standard procedure<sup>18</sup>. Data collection was carried out in August 2019, and all participants attended school classes and had two weekly classes (50 minutes each class) of physical education.

The 24-Hour Movements were considered by accelerometer-based PA, self-reported recreational daily ST, and self-reported SD. For their classification were used the Canadian 24-Hours Movement Guidelines<sup>4</sup>. For PA, the guideline recommends the accumulation of at least 60 minutes per day of

moderate to vigorous PA (MVPA), uninterrupted nine to 11 hours of sleep per night for those aged 5–13 years (age band of the present study participants), and no more than two hours per day of recreational ST.

Accelerometer-based PA was measured using wActiSleep-BT triaxial accelerometers (ActiGraph®). Each participant has worn the device at the right side of the waist fixed by an adjustable and elastic belt for seven consecutive days. Participants were instructed to wear the device all day and for all seven days, and they could remove the device for sleeping, but they should use it again as soon as they woke up. They were instructed not to use the equipment in activities that could wet it, such as during the bath. The selected sampling rate was 100 Hz. Accelerometer data with at least ten hours of use per day and used for at least three days (two weekdays and one weekend day) were considered valid data. Records with 60 consecutive zero minutes were considered non-use<sup>19</sup>. After downloading the information for each accelerometer, an epoch length of five seconds was used, and no bouts were used<sup>20</sup>. The cut-off points proposed by Evenson et al.<sup>21</sup> were used for the identification of time in light (LPA), moderate (MPA), and vigorous (VPA) intensities of PA. Recreational daily ST was assessed by the children's report about average daily time (weekdays) watching TV; playing video games; using computers, smartphones, and tablets for fun (free time). SD was considered by the time children reported usually going to bed and waking up (weekdays)<sup>22</sup>.

### *Statistical Analysis*

The numerical variables were described using the mean and standard deviation or median and interquartile difference for the statistical analyses. The categorical variables were defined using absolute and relative frequencies. The difference in the proportion of participants meeting the 24-Hours Movement Guidelines (individually and combined) by gender (male and female), age group ( $\leq 10$  years old and  $> 10$  years old), and BMI classification (overweight and obese – obese and severe obese were grouped as obese) was performed by Chi-Square test. The significance level was set at  $p < .05$ , and all analyses were conducted using Statistical Package for Social Sciences program (SPSS Inc., Chicago, IL, USA), version 20.0).

## **Results**

The sociodemographic and anthropometric characteristics of the participants are presented in Table 1. Participants were 10.2 ( $\pm 1.27$ ) years old, and most were boys (70.8%). Almost two-thirds were overweight (64.3%), a quarter was obese (24.3%), and 11.4% were severe obese. The mean monthly family income was approximately two national minimum wages.

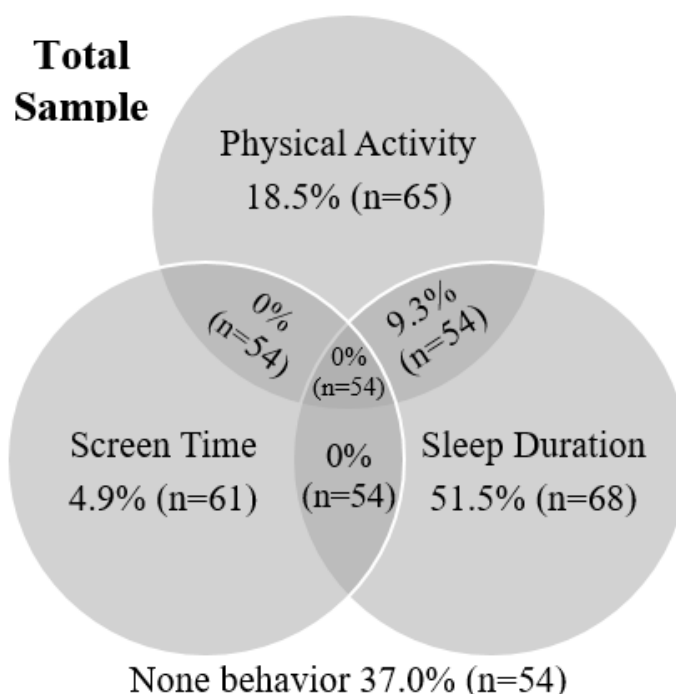
Of the 72 participants, seven did not provide valid accelerometer PA data, 11 did not provide valid data for recreational ST, four did not provide valid data for SD, and 54 had valid data for the three behaviors. The mean of days of use and the hours of use per day of the accelerometer were 5.25 ( $\pm 1.46$ ) and 12.9 ( $\pm 2.05$ ), respectively. The adherence to the 24-Hour Movement Guidelines for each behavior separately was that approximately half of the participants met the Guideline for SD, one-fifth met the Guideline for PA, and only 4.9% met the Guideline for ST (Figure 1). About half of the participants met the recommendation for at least one of the three behaviors. However, more than a third of them did not meet the recommendation for any behaviors. Two behaviors simultaneously were met for only 9.3% (PA and SD), and no participants met the recommendation for all three behaviors simultaneously (Figure 1). Still, no participants were simultaneously meeting the recommendation for ST and PA or for ST and SD.



**Table 1.** Descriptive characteristics of the participants.

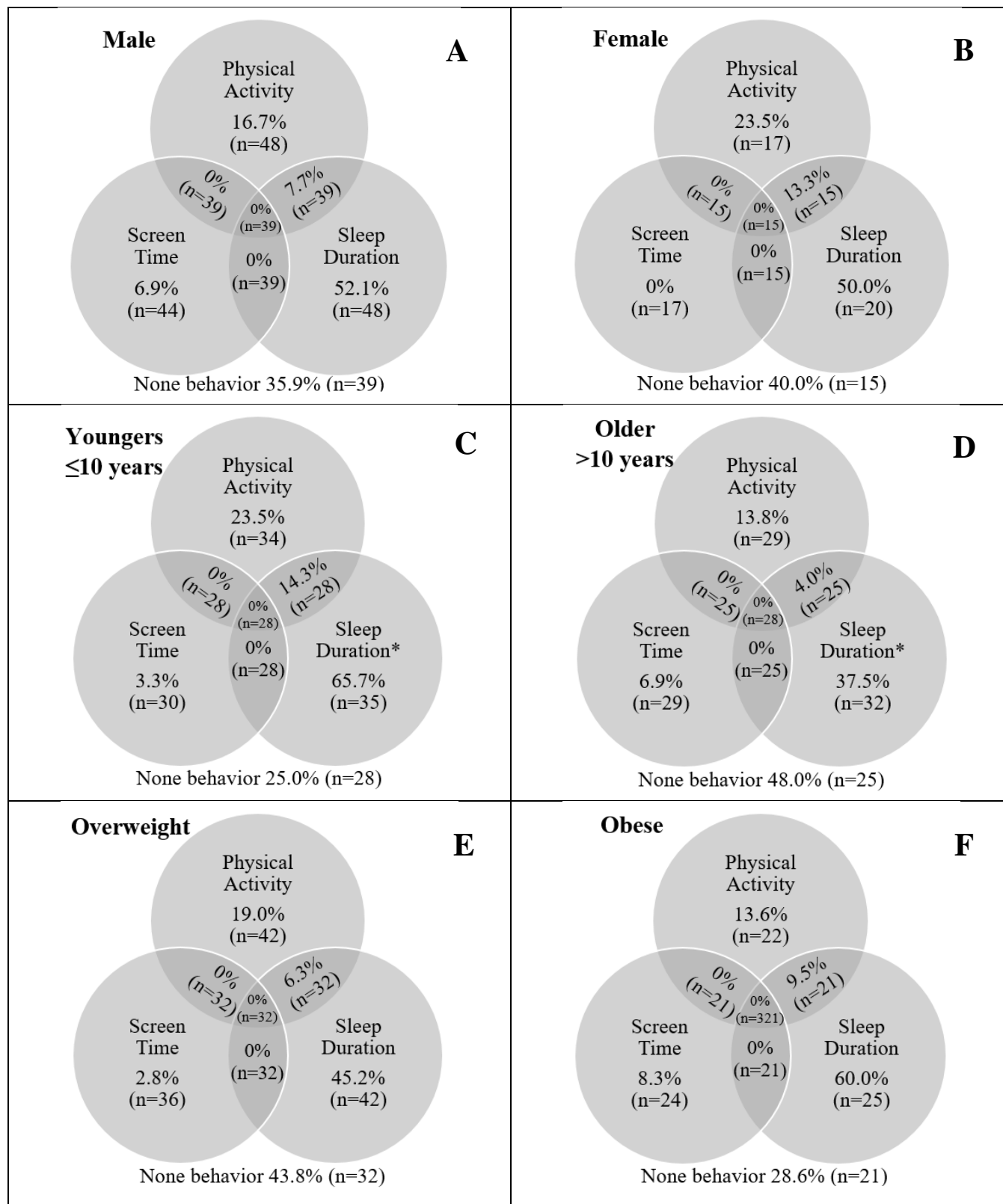
<b>Gender</b>		
	Boys – n(%)	51 (70.8)
	Girls – n(%)	21 (29.2)
<b>Age (years) – <math>\bar{x}</math> (sd)</b>		10.2 (1.27)
<b>Age groups</b>		
	≤10 years – n(%)	37 (51.4)
	>10 years – n(%)	35 (48.6)
<b>Height (cm) – <math>\bar{x}</math> (sd)</b>		145.6 (8.4)
<b>Body weight (kg) – <math>\bar{x}</math> (sd)</b>		51.3 (10.7)
<b>Body Mass Index (kg/m<sup>2</sup>) – <math>\bar{x}</math>(sd)</b>		24.0 (3.93)
<b>BMI classification</b>		
	Overweight – n(%)	45 (64.3)
	Obesity – n(%)	17 (24.3)
	Severe obesity – n(%)	8 (11.4)
<b>Family income – <math>\bar{x}</math> (sd)</b>		
		2.20 (1.41)

$\bar{x}$ : mean; sd: standard deviation; n: absolute frequency; %: relative frequency; BMI: body mass index; family income: mean of family monthly minimum wages.



**Figure 1.** Proportion of participants meeting the 24-Hour Movement Guidelines of each behavior and its combinations.

Concerning the analyses of meeting the 24-hour movement guideline recommendations by gender, age group, and BMI classification, it was observed only one statistically significant association (Figure 2). The proportion of younger participants (≤10 years old) meeting the recommendation for SD (65.7%) was higher (p=.027) than for the older ones (>10 years old - 37.5%).



**Figure 2.** Proportion of participants meeting the 24-Hour Movement Guidelines of each behavior and its combinations by gender (panels A and B), age groups (panels C and D), and BMI classification (panels E and F). \* = p<.05.



## Discussion

The present study examined the prevalence of meeting 24-Hour Movement Guidelines among OW/OB children from low-income conditions and compared this prevalence by gender, age, and BMI classification. The main result of our study showed that none of the participants met the recommendations for all three behaviors simultaneously. Still, only 9.3% of them met two behaviors simultaneously. These findings show that a very low proportion of OW/OB children from low-income conditions meet the recommendations for 24-Hour Movement Guidelines having a high risk of developing factors for chronic non-communicable diseases<sup>1-3,5,7</sup>.

Previous studies in different parts of the world found a low prevalence of children and adolescents meeting the 24-Hour Movement Guidelines<sup>5-10</sup>. A study<sup>5</sup> analyzing children (09-11 years old) from 12 countries found a prevalence of 7.2% of meeting the 24-Hour Movement Guidelines. In this study, data from Brazil showed that only 3.4% of children met the Guidelines for the three behaviors simultaneously, suggesting that the prevalence of meeting the Guidelines for children from Brazil is lower than for children from other countries, such as Australia (14.9%), Canada (14.0%), South Africa (11.9%) and United Kingdom (11.4%). In this regard, another study performed in Brazil<sup>9</sup> analyzing adolescents (14–18 years old) found a prevalence of 3% and 0.2% of meeting the recommendations for 24-Hour Movement Guidelines using self-reported data (MVPA, SD, and ST) and using accelerometer data (MVPA and SD), respectively. Considering that OW/OB children are less likely to meet 24-Hour Movement Guidelines<sup>5, 8</sup>, the present study results are not unexpected, even if no participants simultaneously met the Guidelines for all three behaviors. Although our results provide important information about the adherence to 24-Hour Movement Guidelines of OW/OB children from low-income conditions, analyzing the results of each of the three behaviors may contribute to a better understanding of non-compliance with the 24-Hour Movement Guidelines by none of the participants.

The adherence to PA Guidelines (18.5%) of the present study was lower than other international studies that analyzed the adherence of children and adolescents to the 24-Hour Movement Guidelines using accelerometers to assess PA<sup>5-7</sup>. It was expected considering that OW/OB children and adolescents are less involved in PA practices than eutrophic ones<sup>23,24</sup>. In addition, low-income conditions are associated with fewer opportunities for PA in children<sup>11,13</sup>.

The adherence to SD Guidelines was 51.5%, and, as observed in other studies<sup>6,7,10</sup>, it had the highest adherence to Guidelines compared to PA and ST. However, almost half of the participants slept less than the recommended amount. OW/OB children and adolescents have lower sleep quality than their eutrophic peers, possibly contributing to shorter SD<sup>12,25</sup>. Still, children from low-income conditions have shorter SD than those from high-income. Another possible reason for the low adherence to SD Guidelines is the inverse association between SD and ST in OW/OB children from low-income conditions<sup>12</sup>. The high use of portable screen devices at night before bed and the presence of a TV in the bedrooms seem to contribute to the decrease in SD of this population subgroup<sup>12,26</sup>. The adherence to SD Guidelines was lower in younger than in older participants of the present study, being the only association found involving the behaviors of 24-Hours Movement and gender, age, and BMI classification. This finding may be associated with the class shift at schools. Older participants were enrolled in grades in which classes were in the morning, while younger ones were enrolled in grades in which classes were in the afternoon.

The prevalence of compliance with the ST guideline (4.9%) was the lowest among the three behaviors. Previous studies<sup>5,6</sup> also find ST as the behavior with a lower prevalence of meeting the recommendation. Nonetheless, to our knowledge, the present study showed a lower prevalence of participants meeting the recommendation for this behavior. The features of the own participants of this study may help to understand the results of ST. OW/OB are conditions directly associated with high ST

in children and adolescents<sup>27</sup>. Furthermore, children from low-income conditions are more engaged in ST than those from high-income<sup>28</sup>. Although the evidence above is from a high-income country (USA), a previous population-based study performed in the same city that the present study was performed showed that the daily engagement with screens is similar among 11 years old children from families of different socioeconomic status<sup>29</sup>. These results allow us to speculate that even low-income families have access to screen devices, such as TV, video games, computers, laptops, tablets, and smartphones, helping to understand the low proportion of the present study's children who met the Guidelines for ST.

Considering the features of the participants and the found results, the present study provides important contributions to the elaboration of interventions to improve health-related behaviors, especially for PA, SD, and ST of OW/OB children from low-income conditions. The interventions must consider that the nutritional status and sociocultural conditions in which the participants live may affect the interrelation among these behaviors. OW/OB children show lower competence and motor competence perception<sup>24,30</sup>, and lower self-concept<sup>31</sup> than eutrophic ones. These features may contribute to lower general social acceptance<sup>31</sup> and contribute to them being the target of teasing and bullying<sup>31,32</sup>. These factors contribute to OW/OB children being less active and spending more time in sedentary behaviors, especially ST<sup>23,27</sup>. Associated with these individual features, children from low-income families and living in social vulnerability neighborhoods may have less access to public and quality facilities for PA, less access to after-school structured PA programs, and the perception of unsafety in the neighborhood may contribute to less time engaged in outdoor free play<sup>11,13</sup>. Besides reducing the time in PA, this set of features possibly increases the time these children are inside at home. OW/OB children from low-income conditions spend high time involved in sedentary activities at home, especially watching television and using mobile screen devices<sup>12</sup>. This high ST is often encouraged by parents who prefer their children to perform sedentary and quiet activities inside at home and spend high time on screens<sup>13,28</sup>. In addition, involvement in these activities is often unsupervised and without parents' time limitation, allowing children to remain in screen activities at night before bed, negatively influencing sleep quality and SD<sup>12,26</sup>.

Taking into count this complex interrelation among the behaviors of the 24-Hour Movement<sup>4,26</sup> and the individual and sociocultural features of OW/OB children from low-income families living in social vulnerability neighborhoods that influence these relations, the elaboration of interventions aiming the improvement of health-related behaviors of this population subgroup is a challenge<sup>33-35</sup>. Although results of systematic reviews of interventions targeting the improvement of health-related behaviors of OW/OB children are not consistent<sup>33-35</sup>, the literature indicates that comprehensive and multicomponent interventions are more likely having successful. Although the school setting, including physical education classes, is the primary environment to improve health-related behaviors, after-school structured PA programs, health education, and parental involvement seem to be decisive factors in the effectiveness of interventions<sup>33-36</sup>.

Despite the strengths and practical applications, the number of participants should be pointed out as the main limitation of this study. Even being from a specific population subgroup, the sample size does not allow the generalization of the results. In addition, this limitation may have influenced the no differences in the prevalence of compliance with the 24-Hour Movement Guidelines in comparisons by gender, age, and BMI classification, unlike what was reported in other studies<sup>5,6,9,10</sup>. Still, objective measures of the SD could provide more accurate information about this behavior than those collected by children's self-report.



## Conclusion

In summary, none of the OW/OB children from low-income conditions simultaneously met the recommendations for the three behaviors of the 24-Hour Movement. ST was the behavior with lower adherence to the recommendation. Considering the well-established associations among PA, SD, and ST with different health outcomes, interventions targeting positive health-related behavior change of the OW/OB children from low-income conditions must be performed considering the individual and sociocultural features of this population subgroup.

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### Authorship Contributions

Bergmann GG participated in all stages of the study. Gaya AR contributed to writing the manuscript and critically reviewing the content. Silva LR participated in the study design, data collection and critical review of the content. Cruz JFB, Motta TC, Ferreira GD and Pinheiro ES contributed to writing the manuscript and critically reviewing the content. All authors approved the final version of the manuscript.

### Declaration of conflict of interest

The authors declare no conflict of interest.



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