

Relationship between physical activity and sleep recommendations compliance and excess weight among school children from Temuco, Chile

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ABSTRACT

Introduction. Given the importance of physical activity and sleep for health, different recommendations have been proposed for the pediatric population. The objective of this study was to determine the association between physical activity and sleep recommendations compliance and excess weight in school children from Temuco, Chile.

Population and methods. Physical activity and sleep were measured using ActiGraph wGT3X-BT[®] accelerometers. Excess weight was categorized on two categories: absence (normal weight) or presence (overweight or obesity) based on body mass index.

Results. A total of 183 school children participated (54.1 % were females; mean age = 10.95 ± 1.07). Of them, 85.4 % did not meet physical activity recommendations, whereas 75.6% did not meet sleep recommendations. Significant differences were observed in favor of boys over girls in relation to moderate and vigorous physical activity ($p = 0.002$), but this was not the case for amount of sleep. School children with excess weight showed less time spent in moderate and vigorous activity ($p = 0.004$) and a lower amount of sleep ($p = 0.010$) than normal weight ones. Non-compliance with physical activity recommendations was associated with excess weight (odds ratio [OR] = 8.178; 95 % confidence interval [CI]: 1.465-45.635; $p = 0.017$), but this was not observed in relation to sleep recommendations.

Conclusions. A high percentage of school children do not meet the recommendations for physical activity and sleep. Associations were observed by sex and presence of excess weight. Strategies are required to promote compliance with these recommendations in the pediatric population.

Key words: physical activity, sleep, overweight, obesity, accelerometry.

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INTRODUCTION

The prevalence of excess weight in the pediatric population has experienced an evident increase in recent decades and is considered an epidemic affecting public health worldwide² due to the non-communicable diseases accompanying it.³

Several studies indicate that lack of physical activity may be a major factor contributing to the prevalence of excess weight.⁴ This is a very concerning scenario because lack of physical activity and a sedentary behavior are prevalent in most countries,⁵ and school children usually spend long screen time periods compared to little time engaged in active play.⁶ Regular physical activity offers multiple benefits to the pediatric population.⁷ It reduces the risk for obesity,⁸ improves psychological health, increases self-esteem, and reduces stress.¹⁰ In addition, it promotes the development of perceived social competence,¹¹ improves nervous system maturation,¹² encourages motor competence,¹³ and helps to a better academic performance.¹⁴

Another emerging factor related to excess weight is the amount of sleep.^{15,16} It has been observed that the longer and more stable the amount of sleep, the less likely is for a child to develop metabolic disorders.¹⁷ In recent decades, children's sleep habits have evidenced a negative change compared to previous generations: the amount of sleep has reduced markedly.¹⁸

Given the importance of both physical activity and sleep in relation to child health and well-being, different recommendations have been proposed to have a healthy

day (24 hours). These comprise a combination of amount of sleep, sedentary behavior (screen time), and light, moderate, and vigorous physical activity.¹⁹⁻²¹ The evidence in the Chilean school children population indicates a low compliance with recommendations in relation to sleep,²² screen time,²³ and physical activity.²⁴ Children and adults who do not meet daily physical activity and sleep recommendations may have a higher risk for excess weight.²⁵ Considering the high incidence of excess weight in Chilean school children²⁶ and high levels of physical inactivity,²⁴ the objective of this study is to determine the association between physical activity and sleep recommendations compliance and excess weight in school children from Temuco, Chile.

POPULATION AND METHODS

The sample was selected by convenience, using a non-probabilistic sampling, among children attending 5th and 6th grade at 5 primary schools corresponding to different socio-economic levels and geographic locations in the city of Temuco, Chile. The inclusion criterion was attending 5th or 6th grade of primary school; school children who did not complete all assessments (anthropometry and accelerometry) were excluded.

The sample size was estimated based on the following data: a) 3.7 % of children were active based on an accelerometry from a previous study;²² b) 20 participants per cluster (school grade); c) 5 % significance level; d) 5 % absolute accuracy; and e) size effect of 1.3 based on Williamson et al.²⁷ Therefore, a minimum of 200 participants (10 clusters or school classes) was estimated. Based on an 80 % response, the final sample was made up of 240 participants.

The study protocol was approved by the Ethics Committee of Universidad de La Frontera (record no. 122_17). Parents signed a consent, and school children gave their written assent to participate in the study voluntarily.

Procedures

Study participants were assessed by trained staff at their respective schools, during the Physical Education class, and completed a questionnaire with their sociodemographic information. Their weight and height were measured afterwards. Lastly, school children were instructed on how to use the accelerometers; the devices were delivered; and their correct placement was verified.

Physical activity and amount of sleep

Physical activity, sedentary behavior, and sleep were measured using ActiGraph wGT3X-BT[®] accelerometers (ActiGraph, Pensacola, FL), which were procured through project Fondecyt 11170525, funded by the National Research Agency of Chile. Participants were asked to wear the accelerometer continuously for 7 days²⁸ and to take it off only during activities involving water (e.g., taking a shower). The accelerometer was placed on the right side, at the level of the waist, the midaxillary line, and the iliac crest.

Data were downloaded from the accelerometers in epochs of 60 seconds using the Actilife 6.13.4[®] software (Pensacola, FL, USA). In this study, sedentary time, light physical activity time, moderate physical activity time, and vigorous physical activity time data were used, as expressed in minutes.

First, the non-wear time of the accelerometer was registered. The minimum number of data deemed valid was 4 days of use of at least 10 hours per day, including at least 1 day of the weekend. Then, the amount of sleep and the number of nocturnal awakenings across all business days were estimated using Sadeh's algorithm.²⁹ Leaving out data about not use of the accelerometer and sleep, the times corresponding to sedentary behavior and physical activity at different levels were detected using the cut-off points proposed by Evenson.³⁰ Participants were classified as being physically active if they did an average of 60 minutes of moderate to vigorous physical activity (3-5 metabolic equivalents [METs]) per day.²¹ In addition, the participants were considered to meet the sleep guidelines if they slept an average of 9-11 hours per day, based on Canadian guidelines.¹⁹

Nutritional status

Weight was assessed using a Tanita scale, model UM2204 (precision of 0.2 kg, maximum weight of 136 kg). It was measured with children barefoot and wearing sweatpants and a T-shirt. Height was measured using a Seca[®] stadiometer, model 217 (1 mm precision). The presence or absence of excess weight was determined based on body mass index (BMI), considering the parameters specific for each age and sex established by the World Health Organization.³¹

Normal weight (< 85th percentile) was defined as the "absence of excess weight," whereas overweight and obesity were categorized as the "presence of excess weight" (overweight:

BMI \geq 85th percentile and $<$ 97th percentile; obesity: BMI \geq 97th percentile).

Statistical analysis

Descriptive statistics were estimated (measures of central tendency and absolute and relative frequencies). The Kolmogorov-Smirnov test was used to check if variables followed a normal distribution. The physical activity and sleep variables were compared by sex and compliance with recommendations based on the presence or absence of excess weight using Student's t test or the Mann-Whitney U test, as applicable. The association between compliance with physical activity and sleep recommendations and the presence of excess weight was determined based on a logistic regression analysis adjusted for age, sex, and sedentary behavior time. A value of $p < 0.05$ was considered significant. The statistical analysis was performed with the IBM SPSS 25® software.

RESULTS

A total of 183 school children participated in the study (Figure 1); of them, 54.1 % were females; and participants were aged 9 to 13 years (mean [M] = 10.95; \pm 1.07). Normal weight was observed in 45.9 % (49.4 % of girls and 41.7 % of boys) and excess weight, in 54.1 % (50.6 % of girls and 58.3 % of boys). Table 1 shows the anthropometric characteristics of school children by sex. No significant differences were observed in terms of age or anthropometric characteristics. Table 2 shows the descriptive results of physical activity

and sleep of the sample by sex. Differences were noted in terms of moderate physical activity ($p = 0.001$) and the total of moderate and vigorous physical activity ($p = 0.002$), where boys were observed to be more active than girls. No significant differences were observed in sleep.

Table 3 shows the frequency of compliance with the recommendations for moderate and vigorous physical activity, amount of sleep, and both physical activity and sleeping among school children. As observed, the proportion of school children who met the moderate and vigorous physical activity and sleep recommendations was low. Compliance with both recommendations was non-significant.

Table 4 shows the sample's anthropometric, physical activity, and sleep characteristics based on the presence or absence of excess weight. In relation to physical activity, significant differences were observed in moderate activity ($p = 0.013$), vigorous activity ($p = 0.002$), and total moderate and vigorous physical activity ($p = 0.004$). School children who did not have excess weight were more active. In relation to sleep, significant differences were observed in the amount of sleep ($p = 0.010$): school children who did not have excess weight slept more than those who did.

Lastly, according to the logistic regression model, school children who did not meet the moderate and vigorous physical activity recommendation have a higher probability of having excess weight than those who do (OR = 8.178; $p = 0.017$). No association was

FIGURE 1. Flowchart of study participants

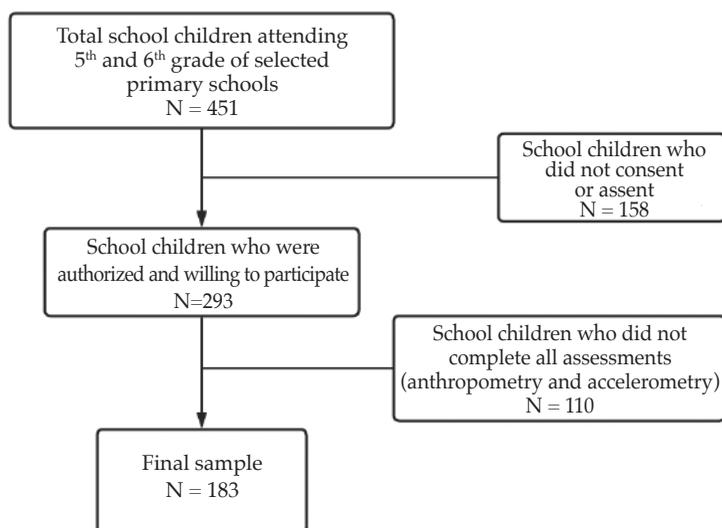


TABLE 1. Demographic characteristics by sex in a sample of school children from the city of Temuco, Chile (n = 183)

| | Sex | | | | | | p |
|--------------------|--------------------|------|-------------------|------|------------------|-----|-------|
| | Total (n = 183) | | Girls (n = 99) | | Boys (n = 84) | | |
| | M | SD | M | SD | M | SD | |
| Age (years) | 11.0 | 1.1 | 10.8 | 0.6 | 11.1 | 1.1 | 0.138 |
| Weight (kg) | 45.2 | 10.2 | 45.4 | 10.6 | 45.0 | 9.9 | 0.823 |
| Height (cm) | 145.0 | 7.3 | 145.5 | 7.3 | 144.4 | 7.4 | 0.390 |
| BMI | 21.4 | 3.8 | 21.3 | 3.9 | 21.4 | 3.6 | 0.851 |

BMI: body mass index.

TABLE 2. Descriptive data for physical activity and sleep by sex in a sample of school children from the city of Temuco, Chile (n = 183)

| | Sex | | | | | | p |
|-------------------------------------|--------------------|------|-------------------|------|------------------|------|-------|
| | Total (n = 183) | | Girls (n = 99) | | Boys (n = 84) | | |
| | M | SD | M | SD | M | SD | |
| Sedentary behavior (min/day) | 453.0 | 67.9 | 453.2 | 66.4 | 452.7 | 70.3 | 0.960 |
| Physical activity (min/day) | | | | | | | |
| Light | 415.8 | 59.5 | 418.1 | 59.5 | 412.8 | 59.8 | 0.570 |
| Moderate | 32.8 | 13.9 | 29.6 | 10.5 | 37.0 | 16.5 | 0.001 |
| Vigorous | 7.9 | 7.8 | 6.8 | 9.3 | 5.7 | 9.6 | 0.055 |
| Moderate and vigorous | 40.7 | 20.0 | 36.3 | 15.0 | 46.1 | 23.9 | 0.002 |
| Sleep | | | | | | | |
| Amount of sleep (min/day) | 514.0 | 42.2 | 516.9 | 46.0 | 510.5 | 3.9 | 0.324 |
| Nocturnal awakenings (n) | 7.8 | 3.7 | 8.0 | 3.6 | 7.5 | 3.2 | 0.399 |

Results expressed as arithmetic mean (M), standard deviation (SD), and percentage. Student's t test or Mann-Whitney U test, as applicable. BMI: body mass index.

TABLE 3. Compliance with physical activity and sleep recommendations measured by accelerometry in a sample of 9 to 13-year old school children from the city of Temuco, Chile (n = 183)

| | Total | | By sex | | | |
|--|-------|------|--------|------|------|------|
| | n | % | Girls | | Boys | |
| | | | n | % | n | % |
| Compliance with physical activity recommendations | | | | | | |
| Non-compliance | 140 | 85.4 | 84 | 92.3 | 56 | 76.7 |
| Compliance | 24 | 14.6 | 7 | 7.7 | 17 | 23.3 |
| Compliance with sleep recommendations | | | | | | |
| Non-compliance | 124 | 75.6 | 64 | 71.1 | 60 | 81.1 |
| Compliance | 40 | 24.4 | 26 | 28.9 | 14 | 18.9 |
| Compliance with both recommendations | | | | | | |
| Non-compliance with both | 123 | 68.3 | 68 | 68.6 | 55 | 67.0 |
| Compliance with one | 52 | 28.9 | 29 | 29.2 | 23 | 28.0 |
| Compliance with both | 6 | 2.8 | 2 | 2.2 | 4 | 5.0 |

observed between compliance with sleep recommendations and the probability of having excess weight (Table 5).

DISCUSSION

The objective of this study was to determine the association between compliance with physical activity and sleep recommendations, as measured with accelerometers, and excess weight among school children from Temuco, Chile. In relation to physical activity levels, the total time spent doing physical activity by the study participants was lower than what has been observed in children with a similar age in Canada (58 min/day) and Australia (65 min/day), but close to that observed

in India (48 min/day) and Brazil (44 min/day).³² In relation to sex, boys did almost 10 minutes more of moderate and vigorous physical activity than girls; this is consistent with several studies that suggested that boys are more active than girls.^{33,34} These results may be explained, in part, by biological factors, including the structure of muscle cells induced by sex hormones,³⁵ as well as the differences in motor competence, for which boys show better performance levels.³⁶

In relation to the amount of sleep, participants slept for a mean of 8.5 hours per day, being lower than those reported in children from Australia (9.4 hours) and Canada (9.1 hours), but similar to what has been observed in school children from

TABLE 4. Anthropometric, physical activity, and sleep characteristics by excess weight in a sample of school children from the city of Temuco, Chile (n = 183)

| | Excess weight | | | | p |
|------------------------------------|-------------------|-------|------------------|-------|-------|
| | Presence (n = 69) | | Absence (n = 80) | | |
| | M | SD | M | SD | |
| Age (years) | 10.9 | 0.63 | 11.1 | 0.66 | 0.152 |
| Weight (kg) | 51.3 | 9.24 | 38.2 | 5.79 | 0.000 |
| Height (cm) | 145.7 | 7.59 | 144.2 | 6.98 | 0.229 |
| BMI | 24.1 | 2.90 | 18.3 | 1.70 | 0.000 |
| Sedentary behavior (min/day) | 458.4 | 65.33 | 448.4 | 71.86 | 0.404 |
| Physical activity (min/day) | | | | | |
| Light | 418.3 | 59.67 | 413.2 | 60.39 | 0.627 |
| Moderate | 29.1 | 10.67 | 34.8 | 14.84 | 0.013 |
| Vigorous | 5.3 | 5.52 | 9.2 | 8.41 | 0.002 |
| Moderate and vigorous | 34.4 | 13.56 | 43.8 | 22.01 | 0.004 |
| Sleep | | | | | |
| Amount of sleep (min/night) | 505.8 | 45.37 | 524.6 | 37.59 | 0.010 |
| Nocturnal awakenings (n) | 4.0 | 0.46 | 3.7 | 0.43 | 0.105 |

Results expressed as arithmetic mean (M) and standard deviation (SD). Student's t test or Mann-Whitney U test, as applicable. BMI: body mass index.

TABLE 5. Adjusted logistic regression model to predict excess weight based on compliance with physical activity and sleep recommendations

| | OR | 95 % CI | | p |
|---|-------|---------|--------|-------|
| | | Lower | Upper | |
| Age | 0.827 | 0.441 | 1.550 | 0.553 |
| Sex | 2.242 | 0.942 | 5.335 | 0.068 |
| Sedentary time | 1.000 | 0.995 | 1.006 | 0.891 |
| Non-compliance with physical activity recommendations | 8.178 | 1.465 | 45.635 | 0.017 |
| Non-compliance with sleep recommendations | 1.297 | 0.512 | 3.287 | 0.584 |

Model adjusted by age, sex, and sedentary behavior time. OR: odds ratio; CI: confidence interval.

Brazil (8.8 hours), China (8.5 hours), and India (8.6 hours).³² Girls' values were slightly higher than those of boys, but this difference was not statistically significant; this is consistent with the results obtained by Toledo-Vargas et al.²² Other studies have reported that boys sleep more,³⁷ so the role of sex on the amount of sleep in the pediatric population is still not clearly defined.

In our study, only 14.6 % of participants complied with physical activity recommendations. Compliance was low when compared to the boys and girls from countries like Australia (55 %), Brazil (44 %) or Canada (44 %), but similar to what has been observed in China (15 %).³³ In relation to sleep recommendations, only 24.4 % of participants met them; this proportion is lower than that observed in other studies done in Chilean school children^{22,26} and than those observed in other countries, like Australia (75 %) and Canada (58 %), but similar to that of Brazil (24 %).³² The assessment of the percentage of the sample that met both physical activity and sleep recommendations found a much lower proportion: 2.8 %. Such extremely low compliance levels are similar to those reported by Toledo-Vargas et al.,²² which puts Chile in a critical situation due to a high percentage of school children at a higher risk for excess weight.

The analysis of physical activity time and amount of sleep based on the presence or absence of excess weight showed that school children without excess weight did almost 9 minutes more of moderate and vigorous physical activity than those with excess weight, and this is in line with the evidence found in other studies.^{37,38}

In addition, school children without excess weight slept almost 20 minutes more per day than those with excess weight; these results are similar to those obtained by Ruiz et al.³⁹ These results are consistent with the emerging tendency about the relationship among physical activity, amount of sleep, and nutritional status, which indicates that a longer and more stable sleep time leads to a child with less probabilities of developing metabolic disorders.¹⁷

The assessment of the association between compliance with moderate to vigorous physical activity and sleep recommendations and the presence of excess weight showed that school children who do not meet the physical activity recommendations have a higher probability of developing excess weight than those who do, similar to what has been reported by Roman-Viñas et al.,⁴⁰ and Katzmarzyk et al.²⁵ In addition,

no association was observed between compliance with sleep recommendations and the presence of excess weight. Although our study found significant differences in the amount of sleep between normal and excess weight school children, a large number of them -regardless of their weight status- did not comply with sleep recommendations, which may explain the lack of association; therefore, such difference indicates the need to study this topic more in depth.

One of the study strengths that is worth noting is the use of accelerometers, which allow to assess both physical activity and sleep levels in a more accurate manner. In addition, one of the limitations of this study is that, considering that it has a cross-sectional design, it is not possible to establish the causality of these results. Similar to what has been observed in another study conducted in the same region of Chile,²² two thirds of the sample considered in the beginning completed the protocol for inclusion in the final analysis; however, the minimum estimated sample size was not reached. Another limitation was that school children's eating habits were not recorded, which may have an effect on results. Also, week days and weekends were not analyzed separately, and the different year periods were not measured, which may have provided additional information about physical activity behavior and the amount of sleep in school children.

CONCLUSIONS

Compliance with physical activity and sleep recommendations in our study sample is low. Boys do more moderate and vigorous physical activity than girls, whereas school children with excess weight show lower physical activity levels than their normal weight peers. In relation to the amount of sleep, no significant differences were observed between males and females, but, in terms of weight, school children with excess weight sleep less time. Non-compliance with physical activity recommendations may be associated with excess weight. No association was observed between compliance with sleep recommendations and the presence of excess weight. ■

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