

# Association between the amount of sleep and obesity in Chilean schoolchildren

Samuel Durán Agüero M.D.<sup>a</sup> and Pablo Haro Rivera M.Sc.<sup>b</sup>

## ABSTRACT

**Introduction.** Studies mainly performed in adults have shown an association between the amount of sleep and obesity.

**Objective.** To determine if there is an association between nocturnal sleep deprivation during the week and the weekend, eating habits, physical activity and nutritional status among Chilean schoolchildren.

**Population, Material and Methods.** Cross-sectional study. An anthropometric assessment was done among 6-11 year-old students; the Pittsburgh Sleep Quality Index (PSQI) was used among parents to measure their children's quality of sleep; they were asked about eating habits and physical activity.

**Results.** One thousand eight hundred and ten schoolchildren of both sexes, attending public schools in Santiago, were assessed. Out of these schoolchildren, 49.9% slept fewer hours per night than recommended. An association in the crude model (crude OR 1.82; CI 95%: 1.29-2.56), in model 2 adjusted for cola drinks (OR 1.83; CI 95%: 1.30-2.59) and in model 3 adjusted for dinner, cola drink and caffeine beverage consumption and nocturia (OR 1.85; CI 95%: 1.30-2.62) was observed. It was also noticed that exercising was a protective factor against overweight and obesity; however, periodic limb movement during sleep was a risk factor.

**Conclusions.** This study showed an association between fewer hours of sleep and an increase in the risk of overweight/obesity.

**Key words:** obesity, sleep, schoolchildren.

<http://dx.doi.org/10.5546/aap.2016.eng.114>

## INTRODUCTION

Childhood overweight and obesity are growing at an alarming rate both in developed and developing countries.<sup>1-3</sup> Chile is no exception: obesity in schoolchildren attending the first year of primary school has almost tripled over the last 22 years, increasing from 8.7% in 1989 to 23.1% in 2011.<sup>4</sup> Childhood obesity is associated with a significant increase in the risk of developing metabolic syndrome in childhood and having chronic health conditions in adulthood, like arterial hypertension, diabetes mellitus, dislipidemia and cardiovascular disease.<sup>5</sup>

The causes of this obesity epidemic cannot be fully explained by changes in traditional lifestyle factors like diet (increase in food intake, serving sizes, sugar consumption, especially sugar-sweetened beverages and sweet snacks) and a decrease in physical activity.<sup>6</sup>

Lately, it has been proposed that a decrease in the amount of sleep can also be one of the causes leading to obesity.<sup>7</sup>

Some of the likely mechanisms are: (a) an alteration of neuroendocrine regulation, appetite and satiety,<sup>8</sup> (b) an alteration of glycidic metabolism<sup>9</sup> and (c) a deregulation of the autonomous nervous system.<sup>10</sup>

Newborn infants' sleep is considered polycyclic since there are multiple sleep-wake periods within 24 hours. On average, an infant sleeps 15 hours including short wake times.<sup>11</sup> This number of hours decreases as they grow older. It is recommended that a schoolchild aged between 5 and 10 should sleep over 10 hours.<sup>12</sup> Sleeping an adequate number of hours is important for the physical and psychosocial development of infants and children. A series of cross-sectional and longitudinal studies have associated short sleep duration to the development of obesity.<sup>13,14</sup> These studies have mostly been carried out in developed countries; there is very little information about studies in developing countries.

The objective of the present study is to determine whether there is an association between nocturnal sleep deprivation during the week and the weekend, eating habits and physical activity, and the nutritional status of Chilean schoolchildren.

a. Degree of Nutrition and Dietetics. School of Health Sciences.

Universidad San Sebastián.

Providencia, Chile.

b. Degree of Nutrition and Dietetics. Health School. Universidad Santo Tomás, Viña del Mar, Chile.

### E-mail Address:

Samuel Durán Agüero M.D.: samuel.duran@uss.cl

### Funding:

None.

### Conflict of interests:

None.

Received: 7-1-2015

Accepted: 10-19-2015

## POPULATION AND METHODS

Cross-sectional study. Schoolchildren of both sexes attending public schools in Santiago de Chile were assessed between March and July, 2014.

The inclusion criterion required participants to be schoolchildren between 6 and 11 years old, and exclusion criteria included those schoolchildren who had not completed the assessments (anthropometric measurement or sleep survey), schoolchildren who had sleep disorders and were under medical treatment and children not living with their parents.

The power of the sample size was calculated at 95%, with a significance level of 5%. The article by Durán et al.<sup>15</sup> was followed, providing a minimum sample of 347 schoolchildren.

The protocol was reviewed and approved by Universidad San Sebastián. Parents were asked to sign an informed consent and schoolchildren gave their assent for the assessment.

### Sleep Questionnaire

The Questionnaire used was the *Pediatric Sleep Questionnaire* (PSQ), which validity, reliability and sensitivity values are higher than 0.80;<sup>16</sup> it has been validated in Spanish.<sup>17</sup> (See Annex)

The survey was conducted among the schoolchildren's parents to determine behavior during their children's sleep.

### Anthropometry

The anthropometric outcome measures studied were weight, height and tricipital skinfold thickness. Weight (kg) was measured using a SECA mechanical scale, with 100 g accuracy, previously calibrated with the subject dressed in minimum clothing.<sup>11</sup> Height (cm) was obtained by measuring the subject with a portable SECA stadiometer, with 1 mm accuracy. Body mass index (BMI) was estimated by dividing the weight by the square of the height—BMI = weight (kg)/square of the height (m<sup>2</sup>).

### Nutritional status

It was classified as per the technical standard of the nutritional status assessment of a 6-18 year-old child. A schoolchild between P10 and less than P85 was considered to have a normal weight, a schoolchild between P85 and less than P95 was considered overweight and a schoolchild at P95 or higher was considered obese.

The above-mentioned measures were calculated via a standardization by professional nutritionists (using international techniques).<sup>18</sup>

### Eating habits

Additionally, parents were asked whether their children had caffeine-containing beverages (coffee, tea or cola drinks) before going to sleep (consumption  $\geq$  1 cup/glass/day) and if they had dinner after 9 p.m. The consumption of any

TABLE 1. General characteristics of the sample (n: 1810)

	Standard weight	Overweight	Obesity
	n= 374	n= 210	n= 224
<b>Girls</b>			
Age (years)	7.8 $\pm$ 1.2 <sup>a</sup>	7.8 $\pm$ 1.2 <sup>b</sup>	7.5 $\pm$ 1.1 <sup>a,b</sup>
Weight (kg)	25.4 $\pm$ 5.3 <sup>a,b</sup>	30.7 $\pm$ 8.5 <sup>b,c</sup>	36.5 $\pm$ 10.1 <sup>a,c</sup>
Height (cm)	125.1 $\pm$ 10.3 <sup>a,b</sup>	128.4 $\pm$ 9.2 <sup>b</sup>	128.5 $\pm$ 9.3 <sup>a</sup>
BMI (kg/m <sup>2</sup> )	16.2 $\pm$ 1.3 <sup>a,b</sup>	19.2 $\pm$ 1.3 <sup>b,c</sup>	22.4 $\pm$ 2.8 <sup>a,c</sup>
Hours of sleep per week	9.8 $\pm$ 1.0	9.9 $\pm$ 1.1 <sup>a</sup>	9.6 $\pm$ 1.0 <sup>a</sup>
Hours of sleep per weekend	10.8 $\pm$ 1.1	10.9 $\pm$ 1.1	10.6 $\pm$ 1.1
Compensation (hours)	1.0 $\pm$ 1.2	1.0 $\pm$ 1.3	1.0 $\pm$ 1.3
<b>Boys</b>			
Age (years)	7.8 $\pm$ 1.2	7.7 $\pm$ 1.2	7.8 $\pm$ 1.2
Weight (kg)	25.7 $\pm$ 5.9 <sup>a,b</sup>	30.1 $\pm$ 7.4 <sup>b,c</sup>	37.0 $\pm$ 11.3 <sup>a,c</sup>
Height (cm)	132.1 $\pm$ 71.9	132.8 $\pm$ 76.2	130.9 $\pm$ 9.4
BMI (kg/m <sup>2</sup> )	16.2 $\pm$ 1.2 <sup>a,b</sup>	18.7 $\pm$ 1.1 <sup>b,c</sup>	22.2 $\pm$ 2.5 <sup>a,c</sup>
Hours of sleep per week	9.9 $\pm$ 1.0 <sup>a</sup>	9.9 $\pm$ 1.1	9.7 $\pm$ 1.0 <sup>a</sup>
Hours of sleep per weekend	11.0 $\pm$ 1.2 <sup>a</sup>	10.8 $\pm$ 0.9	10.7 $\pm$ 1.1 <sup>a</sup>
Compensation (hours)	1.0 $\pm$ 1.2	0.9 $\pm$ 1.1	0.9 $\pm$ 1.1

Data expressed as median  $\pm$  SD. Post hoc Anova test with Bonferroni correction, the same letters indicate significant differences (p < 0.05). BMI: body mass index.

caffeine-containing beverage was considered to be harmful even when occasional (1-3 times per week), because caffeine affects sleep quantity.

### Statistics

Data were entered in an Excel sheet and analyzed using SPSS 22.0. To evaluate the normality of continuous variables (age, weight, height, sleeping hours), the Kolmogorov-Smirnov test was used. Regarding normal variables, the Student's t test was used; for non-normal variables, the Mann-Whitney U test was applied. Moreover, a logistic regression analysis was done to evaluate the association between sleep quantity during the week and the weekend, and the nutritional status, adjusting for cola drinks, caffeine-containing beverages, dinner consumption, nocturia, age, physical activity, limb movement and snoring; 2 adjustment models were chosen: one only with caffeine-containing beverages (this variable was used because Chileans are among the main consumers of cola drinks in the world) and the second by adding other variables. In all cases, a *p* value < 0.05 was considered significant.

### RESULTS

One thousand eight hundred and ten schoolchildren were evaluated; 25 were excluded

because their parents did not sign the informed consent, and 2 of them were under medical treatment. Out of the 25 schoolchildren, 44.5% were female; average age:  $7.7 \pm 1.2$  years old; weight:  $30.2 \pm 9.4$  kg; height:  $129.9 \pm 45.6$  cm; BMI:  $18.7 \pm 3.1$  kg/m<sup>2</sup>; hours of sleep during the week:  $9.8 \pm 1.0$  hours; and during the weekend:  $10.8 \pm 1.1$  hours.

Table 1 shows the anthropometric variables and hours of sleep during the week and the weekend.

Out of all the participants, 49.9% of sleep fewer hours than recommended during the week; this amount decreases to 16.7% during the weekend. Additionally, 51.1% of these schoolchildren have cola drinks in the afternoon-evening; 63.2% have coffee or tea before going to sleep.

The number and percentage of schoolchildren sleeping fewer hours than recommended for their age is shown in Table 2. It can be seen that sleep restriction is higher during the week than during the weekend, and that the older the age the higher the percentage of schoolchildren sleeping fewer hours than recommended; this number doubles in children aged 6 to 10.

Table 3 shows data corresponding to weekdays with OR models obtained from the univariate analysis and then adjusted for cola drinks in model 2 and for dinner, cola drinks, coffee, tea

TABLE 2. Number and percentage of schoolchildren sleeping fewer hours than recommended during the week and the weekend according to age

Age (years old)	Sleeps < 10 h en over the week n (%)	Sleeping hours (median & SD)	Sleeps < 10 h/weekend n (%)	Sleeping hours/weekend (median & SD)
6 years	110 (37.0)	10.1 ± 1.0	40 (13.4)	11.0 ± 1.1
7 years	210 (41.8)	9.9 ± 1.0	92 (18.3)	10.8 ± 1.2
8 years	186 (48.0)	9.8 ± 1.1	40 (10.3)	10.9 ± 1.0
9 years	236 (59.8)	9.6 ± 1.0	86 (21.8)	10.6 ± 1.1
10 years	124 (62.0)	9.4 ± 0.7	38 (19.0)	10.8 ± 1.2

SD: standard deviation.

TABLE 3. Factors associated to short sleep over the week

	Crude model OR (CI 95%)	Adjusted model 2	Adjusted model 3
Nutritional status			
Normal	1	1	1
Overweight/obesity	1.82 (1.29-2.56)*	1.83 (1.30-2.59)*	1.85 (1.30-2.62)
Age < 10 years	-	0.75 (0.52-1.08)	0.78 (0.54-1.12)
Sex (female)	-	1.30 (1.01-1.67)*	1.28 (1.00-1.65)*
Snore	-	1.17 (0.91-1.51)	1.09 (0.85-1.41)
Exercise	-	-	0.72 (0.54-0.97)*
Limb movement (overnight)	-	-	1.57 (1.21-2.03)*

Model 2 adjusted for cola drinks. Model 3 adjusted for dinner, cola drinks, caffeine-containing beverages and nocturia.

\* *p* < 0.05. OR: odds ratio; CI: confidence interval.

and nocturia in model 3. An association in crude models as well as in model 2 and model 3 is observed between fewer sleeping hours during the week and the risk of overweight/obesity (crude OR 1.82; CI 95%: 1.29-2.56, adjusted model 2 OR 1.83; CI 95%: 1.30-2.59 and model 3 OR 1.85; CI 95%: 1.30-2.62).

In the latest model, there are other factors that are positively correlated like being female (OR 1.28; CI 95%: 1.00-1.65) and experiencing limb movement during sleep (OR 1.57; CI 95%: 1.21-2.03), and negatively correlated, like exercising (OR 0.72; IC 95%: 0.54-0.97).

Table 4 shows data corresponding to weekends with OR models obtained from the univariate analysis and then adjusted for cola drinks in model 2 and dinner, cola drinks, coffee and tea, and nocturia in model 3. No association is observed in crude models, model 2 and model 3, and between fewer sleeping hours during the weekend and the risk of overweight/obesity. In these latter model 2 and model 3, there are other factors positively correlated to overweight/obesity, like snoring (OR 1.42; CI 95%: 1.17-1.74), experiencing limb movement during sleep (OR 1.31; CI 95%: 1.08-1.59), having cola drinks (OR 1.45; CI 95%: 1.19-1.76), and negatively correlated like exercising (OR 0.87; CI 95%: 0.74-0.99).

## DISCUSSION

The main result of the present article is that there is an association between fewer sleeping hours during the weekend and an increase in overweight/obesity risk.

Many countries report a high incidence of sleep disorders in youth<sup>19</sup> and, specifically in children, who, given the characteristics of present-day living, are unlikely to be able to

sleep regularly or the appropriate number of hours. Health problems associated to lack of sleep, as well as the possible mechanisms of this association have also been documented.<sup>20,21</sup>

In general, it has been described that both children and adolescents do not get enough sleep at night. Our study found that half of the schoolchildren slept less than is recommended and, therefore, were more prone to experiencing consequences the day after (for instance, feel too tired or sleepy the day after, falling asleep at school or experiencing mood disorders).<sup>22</sup>

Additionally, both laboratory studies and epidemiological evidence point out that sleep deprivation seems to be a significant risk factor for cardiovascular and metabolic disease in adults, like obesity, type 2 diabetes and arterial hypertension, which have a negative impact on public health.<sup>23,24</sup>

Specifically in pediatric patients, cross-sectional studies from around the world show an increase in the continuous risk of obesity among children with a short duration of sleep.<sup>25</sup>

A review of 22 longitudinal studies suggested a reverse association between sleep duration and the BMI among children and adolescents. A meta analysis of 11 longitudinal studies involving 24 821 participants revealed that subjects whose sleeping was within the short duration range had twice as much risk of becoming overweight or obese compared to subjects who slept for long periods (OR 2.15; CI 95%: 1.64-2.81).<sup>26</sup>

Additionally, there are studies suggesting that the chronic lack of sleep from childhood up to school age in children it is associated to a higher metabolic risk<sup>27</sup> and that sleep duration reversely predicts cardiometabolic risk among obese adolescents.<sup>28</sup>

TABLE 4. Factors associated with short sleep over the weekend

	Crude model OR (CI 95%)	Adjusted model 2	Adjusted model 3
Nutritional status			
Normal	1	1	1
Overweight /obesity	1.22 (0.95-1.57)	1.20 (0.93-2.59)	1.19 (0.92-1.54)*
Age < 10 years	-	0.56 (0.39-0.70)*	0.54 (0.40-0.73)*
Sex (female)	-	1.19 (0.98-1.43)	1.17 (0.96-1.41)
Snore	-	1.49 (1.23-1.81)*	1.42 (1.17-1.74)*
Exercise	-	-	0.87 (0.74-0.99)*
Limb movement (overnight)	-	-	1.31 (1.08-1.59)*
Cola drink consumption	-	-	1.45 (1.19-1.76)*

Model 2 adjusted for cola drinks. Model 3 adjusted for dinner, caffeine containing beverages, siesta and nocturia.

\* p < 0.05. OR: odds ratio; CI: confidence interval.

The significant role of sleep in modulating hormonal release could explain the association between fewer sleeping hours and obesity. The greater risk of obesity is possibly related to the effect of decreased sleep on hormones associated to appetite control and energy expenditure, specifically, the decrease of leptin plasma levels and the concomitant increase of ghrelin plasma levels in subjects with sleep restriction with the consequent increase of subjective appetite.<sup>8,29,30</sup> Furthermore, an association between sleep restriction and the different metabolic and endocrine alterations has been suggested, including insulin resistance without a compensatory increase in insulin secretion which results in impaired glucose tolerance and an increase in the risk of type 2 diabetes.<sup>31,32</sup>

In short, evidence suggests that chronic sleep restriction likely contributes to the present epidemic of obesity and type 2 diabetes in the population.

Chile ranks ninth among countries with the most obese children worldwide. This is mainly associated to changes in demographics, socioeconomic eating habits and physical activity;<sup>33</sup> however, it is necessary to consider other factors that might be contributing to this high prevalence in obesity in Chile.

In the study, it is observed that cola drink consumption in the afternoon/evening is associated to a higher risk of overweight/obesity. It is possible that, through different mechanisms, because of their caffeine content, these drinks could alter sleep patterns,<sup>34</sup> and because of sugar-sweetened beverage consumption (regardless of whether they are cola beverages or not), there is an association between this and an increase in the risk of obesity.<sup>35</sup> Cola drink consumption before sleeping is present in 96.7% of schoolchildren; Chile is one of the countries worldwide with the higher consumption of this kind of beverages, being only surpassed by Mexico and the USA.

Among the strengths of this study, we can mention that an internationally validated survey was used and that anthropometry measurements were taken to each schoolchildren; among weaknesses we can say that it is a cross-sectional study therefore, we cannot say there is causality.

It is necessary to conduct longitudinal and intervention studies that could show the effect on an improvement of the nutritional status when there is an adequate sleep hygiene, considering the insufficient sleep quantity at night described among children and adolescents.

## CONCLUSIONS

In our study an association was found between fewer sleeping hours and an increase in the risk of overweight/obesity. Being female and experiencing limb movement during sleep are associated to short duration of sleep; however, exercising seems to have a protective effect. ■

## REFERENCES

- González Jiménez E, Aguilar Cordero MJ, García López PA, Schmidt Río-Valle J, et al. Análisis del estado nutricional y composición corporal de una población de escolares de Granada. *Nutr Hosp* 2012;27(5):1496-504.
- Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obes* 2006;1(1):11-25.
- Wojcicki JM. The double burden household in sub-Saharan Africa: maternal overweight and obesity and childhood undernutrition from the year 2000: results from World Health Organization Data (WHO) and Demographic Health Surveys (DHS). *BMC Public Health* 2014;14:1124.
- Burrows RA, Leiva LB, Weisstaub G, Lera LM, et al. High HOMA-IR, adjusted for puberty, relates to the metabolic syndrome in overweight and obese Chilean youths. *Pediatr Diabetes* 2011;12(3 Pt 2):212-8.
- Gupta N, Goel K, Shah P, Misra A. Childhood obesity in developing countries: epidemiology, determinants, and prevention. *Endocr Rev* 2012;33(1):48-70.
- Summerbell CD, Waters E, Edmunds LD, Kelly S, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2005;(3):CD001871.
- Keith SW, Redden DT, Katzmarzyk PT, Boggiano MM, et al. Putative contributors to the secular increase in obesity: exploring the roads less traveled. *Int J Obes (Lond)* 2006;30(11):1585-94.
- Knutson KL. Impact of sleep and sleep loss on glucose homeostasis and appetite regulation. *Sleep Med Clin* 2007;2(2):187-97.
- Spiegel K, Leproult R, Van Cauter E. Impact of sleep debt on metabolic and endocrine function. *Lancet* 1999;354(9188):1435-9.
- Stamatakis KA, Punjabi NM. Effects of sleep fragmentation on glucose metabolism in normal subjects. *Chest* 2010;137(1):95-101.
- Galland BC, Taylor BJ, Elder DE, Herbison P. Normal sleep patterns in infants and children: a systematic review of observational studies. *Sleep Med Rev* 2012;16(3):213-22.
- Chen X, Beydoun MA, Wang Y. Is sleep duration associated with childhood obesity? A systematic review and meta-analysis. *Obesity (Silver Spring)* 2008;16(2):265-74.
- Carter PJ, Taylor BJ, Williams SM, Taylor RW. Longitudinal analysis of sleep in relation to BMI and body fat in children: the FLAME study. *BMJ* 2011;342:d2712.
- Nielsen LS, Danielsen KV, Sorensen TI. Short sleep duration as a possible cause of obesity: critical analysis of the epidemiological evidence. *Obes Rev* 2011;12(2):78-92.
- Durán S, Fuentes N, Vásquez S, Cediel G, et al. Relación entre estado nutricional y sueño en escolares de la comuna de San Miguel, Santiago, Chile. *Rev Chil Nutr* 2012;39(1):30-7.
- Chervin RD, Hedger K, Dillon JE, Pituch KJ. Pediatric sleep questionnaire (PSQ): validity and reliability of scales for sleep-disordered breathing, snoring, sleepiness, and behavioral problems. *Sleep Med* 2000;1(1):21-32.
- Tomas Vila M, Miralles Torres A, Beseler Soto B. Versión española del Pediatric Sleep Questionnaire. Un instru-

- mento útil en la investigación de los trastornos del sueño en la infancia. Análisis de su fiabilidad. *An Pediatr (Barc)* 2007;66(2):121-8.
18. De Onis M, Onyango AW, Van den Broeck J, Chumlea WC, et al. Measurement and standardization protocols for anthropometry used in the construction of a new international growth reference. *Food Nutr Bull* 2004;25(1 Suppl):S27-36.
  19. Matos MG, Gaspar T, Tome G, Paiva T. Sleep variability and fatigue in adolescents: associations with school-related features. *Int J Psychol* 2015. Epub 2015 May 4.
  20. Sekine M, Yamagami T, Handa K, Saito T, et al. A dose-response relationship between short sleeping hours and childhood obesity: results of the Toyama Birth Cohort Study. *Child Care Health Dev* 2002;28(2):163-70.
  21. Spiegel K, Leproult R, L'hermite-Baleriaux M, Copinschi G, et al. Leptin levels are dependent on sleep duration: relationships with sympathovagal balance, carbohydrate regulation, cortisol, and thyrotropin. *J Clin Endocrinol Metab* 2004;89(11):5762-71.
  22. Hoban TF. Sleep disorders in children. *Continuum (Minneapolis Minn)* 2013;19:185-98.
  23. Briancon-Marjollet A, Weiszenstein M, Henri M, Thomas A, et al. The impact of sleep disorders on glucose metabolism: endocrine and molecular mechanisms. *Diabetol Metab Syndr* 2015;7:25.
  24. Chaput JP, McNeil J, Despres JP, Bouchard C, et al. Short sleep duration as a risk factor for the development of the metabolic syndrome in adults. *Prev Med* 2013;57(6):872-7.
  25. Miller AL, Lumeng JC, LeBourgeois MK. Sleep patterns and obesity in childhood. *Curr Opin Endocrinol Diabetes Obes* 2015;22(1):41-7.
  26. Fatima Y, Doi SA, Mamun AA. Longitudinal impact of sleep on overweight and obesity in children and adolescents: a systematic review and bias-adjusted meta-analysis. *Obes Rev* 2015;16(2):137-49.
  27. Cespedes EM, Rifas-Shiman SL, Redline S, Gillman MW, et al. Longitudinal associations of sleep curtailment with metabolic risk in mid-childhood. *Obesity (Silver Spring)* 2014;22(12):2586-92.
  28. Iglayreger HB, Peterson MD, Liu D, Parker CA, et al. Sleep duration predicts cardiometabolic risk in obese adolescents. *J Pediatr* 2014;164(5):1085-90.
  29. Kim TW, Jeong JH, Hong SC. The impact of sleep and circadian disturbance on hormones and metabolism. *Int J Endocrinol* 2015;2015:591729.
  30. St-Onge MP, O'Keefe M, Roberts AL, RoyChoudhury A, et al. Short sleep duration, glucose dysregulation and hormonal regulation of appetite in men and women. *Sleep* 2012;35(11):1503-10.
  31. Van Cauter E, Spiegel K, Tasali E, Leproult R. Metabolic consequences of sleep and sleep loss. *Sleep Med* 2008;9(Suppl 1):S23-8.
  32. Knutson KL. Sleep duration and cardiometabolic risk: a review of the epidemiologic evidence. *Best Pract Res Clin Endocrinol Metab* 2010;24(5):731-43.
  33. Vio F, Albala C, Kain J. Nutrition transition in Chile revisited: mid-term evaluation of obesity goals for the period 2000-2010. *Public Health Nutr* 2008;11(4):405-12.
  34. Tran J, Lertmaharit S, Lohsoonthorn V, Pensuksan WC, et al. Daytime sleepiness, circadian preference, caffeine consumption and use of other stimulants among Thai college students. *J Public Health Epidemiol* 2014;8(6):202-10.
  35. Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. *Am J Clin Nutr* 2006;84(2):274-88.

## Annex. Pediatric Sleep Questionnaire

A. Behaviour of your child during sleep and during the night:				
<b>While sleeping does your child...</b>				<i>Do not fill in this column</i>
...sometimes snore?	Y	N	DK	A1
...snore more than half the time?	Y	N	DK	A2
...always snore?	Y	N	DK	A3
...snore loudly?	Y	N	DK	A4
...breathe heavily or loudly?	Y	N	DK	A5
...have trouble breathing, or struggle to breathe?	Y	N	DK	A6
<b>Have you ever...</b>				
...seen your child stop breathing during the night?	Y	N	DK	A7
If this were the case, please describe what happened:				
...been concerned about your child breathing during sleep?	Y	N	DK	A8
...had to move or shake your child while they were sleeping so that they would start breathing again or wake up and start breathing again?	Y	N	DK	A9
...seen your child wake up with a snorting sound?	Y	N	DK	A11
<b>Does your child...</b>				
...have restless sleep?	Y	N	DK	A12
...refer having leg restlessness or discomfort when being in bed?	Y	N	DK	A13
...have growing pains (leg pains without a clear cause)?	Y	N	DK	A13a
...have growing pains that get worse when in bed?	Y	N	DK	A13b
<b>During sleep, have you ever seen your child...</b>				
...give small kicks with one or both legs?	Y	N	DK	A14
...give regular kicks or leg twitches (i.e., every 20 or 40 seconds)?	Y	N	DK	A14a
<b>During the night, does your child generally...</b>				
...sweat or soak pajamas in sweat?	Y	N	DK	A15
...wake up and get out of bed (whatever the cause)?	Y	N	DK	A16
...get out of bed to pee?	Y	N	DK	A17
If this is the case, on average, how many times per night?			(N <sup>o</sup> of times)	A17a
Does your child generally sleep with their mouth open?	Y	N	DK	A21
Does your child generally have a blocked or stuffed nose during the night?	Y	N	DK	A22
Does your child have any type of allergy that makes it difficult for them to breathe naturally through the nose?	Y	N	DK	A23
<b>Does your child...</b>				
...tend to breathe with their mouth open during the day?	Y	N	DK	A24
...have a dry mouth when they wake up in the morning?	Y	N	DK	A25
...have a stomachache during the night?	Y	N	DK	A27
...has a burning sensation in their throat during the night?	Y	N	DK	A29
...grind their teeth during the night?	Y	N	DK	A30
...wet their bed every once in a while?	Y	N	DK	A32
Has your child ever sleepwalked (somniaambulism)?	Y	N	DK	A33
Have you ever heard your child talking in their sleep?	Y	N	DK	A34
Does your child have nightmares once a week or more (on average)?	Y	N	DK	A35
Has your child ever woken up screaming during the night?	Y	N	DK	A36
Has your child ever moved or behaved in such a way that made you think he was not completely awake nor asleep?	Y	N	DK	A37
If this is the case, please describe what happened:				
Does your child find it difficult to fall asleep at night?	Y	N	DK	A40
How long does it take for your child to fall asleep at night? (approximately)			minutes	A41
When it's time to go to bed, does your child have complicated "routines" or "rituals", frequently put up a fight or misbehave?	Y	N	DK	A42
<b>Does your child...</b>				
...bump their head against something or swing their body when falling asleep?	Y	N	DK	A43
...wake up more than twice during the night (on average)?	Y	N	DK	A44
...find it difficult to fall back asleep after they wake up at night?	Y	N	DK	A45
...wake up at a different time every day?	Y	N	DK	A46
...wake up very early in the morning and then find it difficult to fall back asleep?	Y	N	DK	A47
...fall asleep at a very different time every day?	Y	N	DK	A48
<b>What time does your child generally...</b>				
...go to bed during weekdays?				A49
...go to bed during weekends or holidays?				A50
...get up during weekdays?				A51
...get up during weekends or holidays?				A52

<b>B. Behavior of your child during daytime and other problems</b>					
<b>Does your child...</b>					<i>Do not fill in this column</i>
...feel tired when they wake up in the morning?	Y	N	DK		B1
...fall asleep during the day?	Y	N	DK		B2
...complain that they feel sleepy during the day?	Y	N	DK		B3
Has your child's teacher or any other caregiver ever told you that your child looks sleepy during the day?	Y	N	DK		B4
Does your child take a nap during the day?	Y	N	DK		B5
Does your child find it difficult to wake up in the morning?	Y	N	DK		B6
Does your child complain that their head aches in the morning when they wake up?	Y	N	DK		B7
Does your child complain that their head aches at least once a month, on average?	Y	N	DK		B8
Has your child ever "stopped" growing since they were born?	Y	N	DK		B9
If this is the case, please describe what happened:					
Does your child still have their tonsils?	Y	N	DK		B10
If this is not the case, when and why did they get their tonsils removed?					
<b>Has your child ever...</b>					
...had a medical condition that made it difficult for them to breathe?	Y	N	DK		B11
If this is the case, please describe the condition:					
...undergone surgery?	Y	N	DK		B12
...had breathing problems before, during or after surgery?	Y	N	DK		B12a
...felt their legs or any other part of their body were weak after laughing or getting surprised by something?	Y	N	DK		B13
...felt as if they could not move for a short period of time while being in bed but awake and conscious?	Y	N	DK		B15
...felt an uncontrollable urge to take a nap that forced them to drop what they were doing in order to get some sleep?	Y	N	DK		B16
...felt as if they were dreaming (seeing images or hearing sounds) while being awake?	Y	N	DK		B17
Does your child drink caffeine-containing beverages on normal days (coca-cola, coffee or tea)?	Y	N	DK		B18
			cups/cans		B18a
If this is the case, please indicate how many cups or cans they drink per day.	Y	N	DK		B19
Does your child take any type of drugs? If this is the case, please indicate which drug and how often they take it.	Y	N	DK		B20
Does your child smoke?	Y	N	DK		B22
If this is the case, please indicate how many cigarettes they smoke per day.	Y	N	DK		B22a
Is your child overweight (i.e. do they weigh more than the average for their age)?	Y	N	DK	years old	B23
If this is the case, please indicate at what age this became a problem.	Y	N	DK		B24
Has your child's doctor ever told you that your child has a high-arched palate (the roof of the mouth)?	Y	N	DK		B24
Has your child ever taken Rubifen because of behavioral problems?	Y	N	DK		
Have you ever been told that your child suffers from attention deficit disorder with hyperactivity (ADDH)?	Y	N	DK		B25
<b>C. Please mark the correct box with an X</b>					
	Never	Sometimes	Several times	Almost always	Do not fill in this column
They fail to pay attention to details, they make careless mistakes in their homework	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C1
They find it difficult to concentrate while doing their homework and playing games	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C2
They don't seem to listen when spoken to	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C3
They don't follow instructions or don't finish their work at school or at home, even though they understand the tasks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C4
They find it difficult to organize their activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C5
They avoid engaging in tasks that require sustained mental effort	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C6
Often loses things necessary for tasks or activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C7
They get distracted easily by irrelevant stimuli	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C8
They are careless in daily activities	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C9
They fidget their hands and feet while seated	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C10
They get up from their seat in class or other situations where they are expected to remain seated	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C11
They run or jump in inappropriate situations	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C12
They find it difficult to play or engage in leisure activities quietly	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C13
They are often "on the go" or seem "wired"	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C14
They talk too much	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C15
They answer or act before someone finishes a question	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C16
They find it difficult to wait for their turn	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C17
They interrupt conversations or games played by others	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	C18