SciMedCentral

Journal of Sleep Medicine & Disorders

Research Article

Actigraphy-Measured Sleep Duration in Relation to General and Central Obesity in Patagonian Children with Disabilities

Xiaoli Chen[1]*, Anjalene Whittier[2], Juan Carlos Velez[3], Clarita Barbosa[3], Micah Pepper[3], Bizu Gelaye[1,2] and Michelle A. Williams[1,2]

[1]Department of Epidemiology, Harvard T.H. Chan School of Public Health, Boston, USA
[2]Multidisciplinary Health International Research Training Program, Harvard T.H. Chan School of Public Health, Boston, MA 02115, USA
[3]Centro de Rehabilitación Club de Leones Cruz del Sur, Punta Arenas, Chile

***Corresponding author**
Xiaoli Chen, Department of Epidemiology, Harvard T.H. Chan School of Public Health 677 Huntington Ave, Kresge 500, Boston, MA 02115, Tel: 617-432-0067; Fax: 617 566-7805; Email: xchen@hsph.harvard.edu

Submitted: 20 December 2015

Accepted: 18 January 2016

Published: 20 January 2016

ISSN: 2379-0822

Keywords
- Child
- Disability
- Obesity
- Body mass index
- Body fat percentage
- Actigraphy

Abstract

Purpose: To evaluate the prevalence of obesity and to examine whether actigraphy-measured sleep duration was related to obesity measures among children with disabilities.

Methods: A cross-sectional study was conducted among 125 children aged 6-12 years (boys: 55.2%) receiving care at a rehabilitation center in Chile. Body mass index (BMI) was calculated from measured weight and height. Body fat percentage was assessed using bioelectrical impedance. One-week wrist actigraphy was used to measure sleep duration. Interviewer-administered questionnaires were used to collect information on sociodemographic and lifestyle factors from caregivers. Linear and logistic regression models were fitted to evaluate associations between sleep duration and obesity with adjustment for covariates from children and caregivers.

Results: Approximately 31.2% of children had general obesity (BMI ≥95th percentile). Adjusted means of children's BMI were 22.5 kg/m^2 (standard error [SE]=1.2) for sleep <7 hours, 19.9 kg/m^2 (SE=0.6) for sleep 7-8 hours, and 19.5 kg/m^2 (SE=0.5) for sleep ≥8 hours. Adjusted means of body fat percentage were 28.3% (SE=2.4) for children with sleep <7 hours, 26.5% (SE=1.1) for children with sleep 7-8 hours, and 24.6% (SE=1.0) for children with sleep ≥8 hours. Children who slept <7 hours had significantly higher BMI (beta=3.02, SE=1.32; P=0.025) than children with sleep ≥8 hours. Children with short sleep had high odds of general obesity and central obesity (upper quartile of body fat percentage).

Conclusions: Actigraphy-measured sleep duration was inversely associated with both general and central obesity measures among children with disabilities. Further research is needed to examine effects of sleep interventions on obesity in this vulnerable population.

INTRODUCTION

There are over 100 million children with disabilities in the world [1]. Children with disabilities have a high prevalence of obesity as compared to children without disabilities [2-8]. Of note some researchers have reported that children with disabilities are almost twice as likely to be obese compared to children without disabilities [5-8]. For example, according to the National Health and Nutrition Examination Survey (NHANES) 1999-2002, the prevalence of obesity was 29.7% among children with physical disabilities, while 15.7% of children without disabilities were obese in the US [5]. As obesity is associated with various detrimental health outcomes [9], effective obesity intervention programs should be developed among children with disabilities. Identifying obesity risk factors is important before conducting obesity interventions in this vulnerable population.

There are a variety of unhealthy lifestyle factors that have been reported to be associated with childhood obesity, such as poor diet, soft drinks, long screen time, and physical inactivity, as well as parental obesity [2,6,10-13]. Although the association between short sleep and childhood obesity has been increasingly recognized [14-16], few studies have used objective measures of sleep duration to accurately evaluate this association among children with disabilities. Actigraphy-measured sleep duration offers great opportunities to obtain objective measures of sleep in children's typical environment. Actigraphy has been validated for objective measures of sleep in both clinical- and population-based studies [17,18].

This study aimed to investigate the prevalence of obesity among children with disabilities and to examine whether actigraphy-measured sleep duration is associated with children's obesity measures independent of various characteristics from both children and caregivers. We used both general and central obesity measures including body mass index (BMI) and body fat percentage in children with disabilities. As there are discrepancies between objective measures of sleep and those reported by parents [19], we used actigraphy-measured sleep duration for children with disabilities.

METHODS

Study Participants

The Chile Pediatric and Adult Sleep and Stress Study (CPASS) were established in September 2012 at the Rehabilitation Center in Punta Arenas, Chile. The goals of the CPASS were to investigate objectively measured sleep patterns using wrist actigraphy and sleep related health outcomes among both children with disabilities and their caregivers. The first wave of the CPASS (CPASS I) was conducted between September and December in 2012 [20]. In total, 110 children aged 6-12 years who were receiving routine outpatient services (e.g., physical therapy) for their chronic health conditions at the center and their primary adult caregivers (one caregiver per child) were recruited in the study. Caregivers included parents, grandparents, relatives, or other adults who were principally responsible for their children's wellbeing and did not have developmental/intellectual disabilities. A total of 105 child-caregiver dyads (95.5% of enrolled pairs) completed the CPASS I study protocol with complete data. The second wave of the CPASS (CPASS II) was conducted between April and July in 2013 among children and adolescents aged 10-21 years who were receiving routine outpatient rehabilitation service at the center and their primary adult caregivers [21,22]. Research personnel invited 129 caregivers and their children to participate, and 90 caregivers (69.8%) agreed to participate. Of these, 20 children were aged 10-12 years in the CPASS II. As these two waves (CPASS I and CPASS II) were conducted between September 2012 and July 2013 at the same rehabilitation centre in Chile, with the same staff and with identical study protocols used for assessing sleep traits and obesity measures, we combined the results from the two waves in order to have a larger sample size with increased statistical power in this study. The final sample size of this study was determined on the basis of available resources (e.g., ActiSleep monitors) and not based on formal a priori sample size and statistical power determinations. In total, 125 children aged 6-12 years and their caregivers were included in the current study.

Study Procedures

Structured interviewer-administered questionnaires were used to collect data from caregivers on sociodemographic factors, caregiver-child relationship (e.g., mother), children's diet quality, caffeinated beverage consumption, physical activity, daytime napping, and screen time (e.g., television watching and computer use). Electronic medical records were reviewed to confirm children's disability diagnoses. A trained research nurse took anthropometric measurements when children and caregivers were wearing light clothing without shoes. With an electronic scale (TANITA® BC 420 SMA; Tanita Europe GmbH), weight was measured to the nearest 0.1 kg; body fat percentage using bioelectric impedance analysis (BIA) was measured to the nearest 0.1%. Height was measured with a telescopic height measuring instrument (SECA 225; SECA Ltd) to the nearest 0.1 cm. Caregivers' waist and hip circumferences were measured with an inelastic tape (SECA 200, precision 0.1 cm, range 0–150 cm; Seca Ltd), with participants in a standing position. All measures were taken twice and the averages of these measures were used. Children wore ActiSleep monitors (ActiLife, Acti Graph R&D, Florida, USA) [23] on their non-dominant wrists for seven consecutive days. Caregivers were instructed to complete concurrent sleep logs for their children while actigraphy was measured. This study was approved by the institutional review boards of Harvard T. H. Chan School of Public Health and the Centro de Rehabilitation Club de Leones Cruz del Sur in Punta Arenas, Chile.

Obesity Measures

BMI was calculated by dividing weight (kg) by height squared (m^2). Based on the US Centers for Disease Control and Prevention Growth Charts [24], children's weight status was defined as normal weight (BMI <85^{th} percentile), overweight (85^{th} ≤ BMI <95^{th} percentile), and obesity (BMI ≥95^{th} percentile). Children's central obesity was defined using upper quartiles of body fat percentage.

Sleep Duration

Actigraphy-measured sleep data including sleep duration were collected using the ActiSleep monitors and were analyzed using the ActiLife 6 data analysis software [23]. Actigraphy data were collected in 1-min epochs using the zero-crossing modes, and the "Sadeh" sleep algorithm was used for children [25]. Most children (97.6%, 122 of 125) had 7-day complete sleep data; two children had 6-day and one child had 3-day complete actigraphic data available. We used caregivers' sleep logs of children's bedtime and wake-up time to assess actigraphically measured sleep data including sleep latency and sleep duration. The average sleep duration over the 7-day period was calculated. According to the literature of sleep duration [14] and the distribution of data in this study (median sleep duration: 8 hours; only 9.6% of children had sleep ≥ 9 hours), we categorized short sleep duration as <7 hours and 7-8 hours.

Covariates

The following potential confounding variables were considered: children's sex, age, disability type, caregiver-reported lifestyle behaviors including diet quality, caffeinated beverage consumption, daytime napping, physical activity, screen time, caregiver-child relationship, and caregivers' age, race/ethnicity, educational attainment, and caregivers' obesity status. According to the International Classification of Diseases (ICD-10) [26], children's disabilities were grouped as: 1) mental and behavioral disorders (e.g., autism); 2) diseases of the musculoskeletal system and connective tissue, skin and subcutaneous tissue (e.g., scoliosis); 3) diseases of the nervous system (e.g., cerebral palsy); and 4) congenital malformations, deformations and chromosomal abnormalities (e.g., Down syndrome). BMI was used to define caregivers' general obesity (BMI ≥30 kg/m^2) according to the World Health Organization (WHO) criteria. Caregivers' central obesity was evaluated using the WHO criteria: waist-to-hip ratio (WHR) ≥0.9 for men and WHR ≥0.85 for women [27].

Statistical Analyses

Chi-square tests or Fisher's exact tests were used to evaluate differences in sociodemographic and lifestyle factors by child sex. General linear models were fitted to estimate least-square means and standard errors (SEs) of BMI and body fat percentage across sleep duration categories (<7 hours, 7-8 hours, ≥8 hours) with adjustment for children's sex, age, disability type, diet quality (poor vs. good), physical inactivity (yes vs. no), caffeinated beverage consumption (yes vs. no), daytime napping (yes vs. no), screen time (>2 vs. ≤2 hours/day), caregiver-child relationship (other vs. mother), caregivers' age, race/ethnicity (other vs. Hispanic), education (<high school, high school vs. >high school), and obesity status (yes vs. no). As several children were unable to stand on the scale due to their health conditions or disabilities (e.g., cerebral palsy), only 119 children had data for body fat percentage. Univariate and multivariable linear regression models were fitted to evaluate associations of children's sleep duration with BMI and body fat percentage. Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated to examine the associations of sleep duration (<7 hours, 7-8 hours, vs. ≥8 hours) with child obesity in logistic regression models. Stratified analysis by children's disability type was conducted to examine whether the associations varied by disability. We also included the study wave (e.g., CPASS I and CPASS II) in multivariable regression models and found similar results (data not shown). All analyses were completed using SAS 9.3 (SAS Institute, Cary, NC). Statistical significance levels were set at P <0.05 for two-sided analyses.

RESULTS

The mean age of 125 children (boys: 55.2%) was 9.2 years (standard deviation [SD]: 2.2) (Table 1). Mental and behavioral disorders were more common in boys than in girls. Approximately 10.4% of children had actigraphy-measured sleep duration <7

Table 1: Characteristics of children with disabilities and their primary caregivers, according to child sex.

	Total, n (%) (n=125)	Boys, n (%) (n=69)	Girls, n (%) (n=56)	P value
Child characteristics				
Age (years), mean (SD)	9.2 (2.2)	8.8 (2.1)	9.8 (2.3)	0.015
Type of disability diagnosis[a]				
Mental and behavioral disorders	60 (48.0)	41 (59.4)	19 (33.9)	0.004
Diseases of the musculoskeletal system and connective tissue, skin and subcutaneous tissue	21 (16.8)	7 (10.1)	14 (25.0)	
Diseases of the nervous system	34 (27.2)	19 (27.5)	15 (26.8)	
Congenital malformations, deformations and chromosomal abnormalities	10 (8.0)	2 (2.9)	8 (14.3)	
Poor diet quality	31 (24.8)	17 (24.6)	14 (25.0)	0.963
Caffeinated beverage consumption[b]	60 (48.0)	37 (53.6)	23 (41.1)	0.163
Physical inactivity	38 (30.4)	21 (30.4)	17 (30.4)	0.993
Screen time ≥ 2 hours/day	71 (56.8)	39 (56.5)	32 (57.1)	0.944
Daytime napping	21 (16.8)	10 (14.5)	11 (19.6)	0.444
Actigraphy-measured sleep duration				
<7 hours	13 (10.4)	9 (13.0)	4 (7.1)	0.557
7-8 hours	51 (40.8)	27 (39.1)	24 (42.9)	
≥ 8 hours	61 (48.8)	33 (47.8)	28 (50.0)	
BMI (kg/m^2), mean (SD)	20.0 (4.8)	19.9 (4.3)	20.1 (5.3)	0.799
Body fat percentage (%), mean (SD)[c]	25.8 (8.3)	24.2 (8.0)	27.8 (8.4)	0.018
General obesity (BMI≥95th percentile)[d]	39 (31.2)	28 (40.6)	11 (19.6)	0.012
Central obesity (upper quartile of body fat %)[c]	30 (25.2)	12 (18.2)	18 (34.0)	0.049
Caregivers				
Age (years), mean (SD)	38.3 (7.8)	38.5 (7.8)	38.0 (7.8)	0.690
Race/Ethnicity (Other vs. Hispanic)	54 (43.2)	32 (46.4)	22 (39.3)	0.426
Caregiver: mother	110 (88.0)	61 (88.4)	49 (87.5)	0.877
Education				
<High school	27 (21.6)	17 (24.6)	10 (17.9)	0.088
High school	47 (37.6)	20 (29.0)	27 (48.2)	
>High school	51 (40.8)	32 (46.4)	19 (33.9)	
General obesity (BMI ≥ 30 kg/m^2)	45 (36.0)	24 (34.8)	21 (37.5)	0.753
Central obesity[e]	73 (58.4)	41 (59.4)	32 (57.1)	0.797

Abbreviations: BMI: Body Mass Index; SD: Standard Deviation
[a]**Disability group:** mental and behavioral disorders (e.g., autism, ADHD, mental retardation); diseases of the musculoskeletal system and connective tissue, skin and subcutaneous tissue (e.g., scoliosis); diseases of the nervous system (e.g., cerebral palsy); congenital malformations, deformations and chromosomal abnormalities (e.g., Down syndrome). [b]Caffeinated beverage consumption included soda, tea, or coffee. [c]Only 119 children had data for body fat percentage. [d]Based on the US Centers for Disease Control and Prevention Growth Charts, 2000. [e]According to the World Health Organization (WHO) criteria, central obesity was defined as waist-to-hip ratio > 0.90 for men and > 0.85 For women.

hours. Girls had higher body fat percentage than boys. In total, 31.2% of children were obese (BMI ≥95th percentile); 25.2% of children had high body fat percentage defined by having the upper quartile of body fat percentage 32.2% and greater. The mean age of caregivers was 38.0 (SD =7.8) years. Most caregivers were mothers (88.0%). Among caregivers, 36.0% of them had general obesity (BMI ≥30 kg/m^2) while 58.4% had central obesity defined using WHR ≥0.9 for men and WHR ≥0.85 for women. There were no significant differences in caregiver-reported lifestyle factors for children, caregiver-child relationship, caregivers' sociodemographic characteristics or obesity status between boys and girls.

Child age, sex, disability type, and other factors-adjusted mean of children's BMI was 22.5 kg/m^2 (SE=1.2) for children who had <7 hours of sleep, 19.9 (SE=0.6) for those with 7-8 hours of sleep, and 19.5 (SE=0.5) for those with sleep ≥8 hours (Figure 1). The adjusted mean of body fat percentage was 28.3% (SE=2.4) for children with sleep <7 hours, 26.5% (SE=1.1) for children with sleep 7-8 hours, and 24.6% (SE=1.0) for children with sleep ≥8 hours (Figure 2).

Table 2 presents univariate and multivariable linear regression models for the associations of children's sleep duration with BMI and body fat percentage. As compared with children who had ≥8 hours of sleep, children with <7 hours of sleep had significantly higher BMI (beta=4.14, SE=1.42; P=0.004) and marginally significantly greater body fat percentage (beta =4.76, SE =2.61; P=0.071). There was a clear dose-response relationship between short sleep duration and higher BMI (P_{trend} =0.007) and greater body fat percentage (P_{trend} =0.028). With adjustment for children's sex, age, disability type, diet quality, physical inactivity, caffeinated beverage consumption, daytime napping, screen time, caregiver-child relationship, caregivers' age, race/ethnicity, education, and obesity status, children who slept <7 hours had significantly higher BMI (beta=3.02, SE=1.32; P=0.025) than children with sleep ≥8 hours. Children with short sleep <7 hours had greater body fat percentage as compared to children with sleep ≥8 hours (beta =3.70, SE =2.71), although the P value did not reach a statistical significance level (P =0.176).

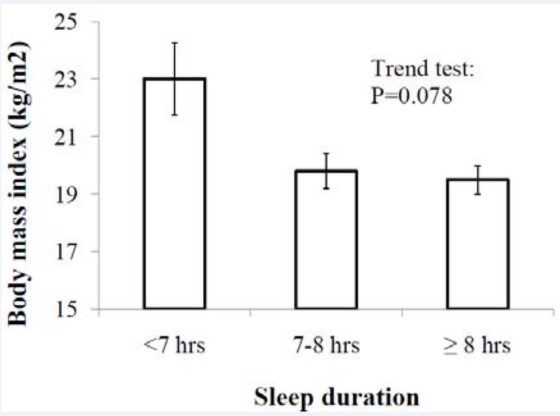

Figure 1 Adjusted means of children's body mass index with standard errors across actigraphy-measured sleep duration categories.

Adjusted for children's sex, age, disability type, diet quality, physical inactivity, caffeinated beverage consumption, daytime napping, screen time, caregiver-child relationship, and caregivers' age, race/ethnicity, education, and obesity status.

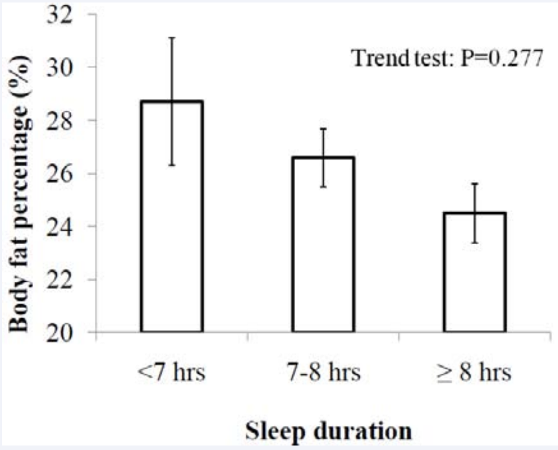

Figure 2 Adjusted means of children's body fat percentage with standard errors across actigraphy-measured sleep duration categories.

Adjusted for children's sex, age, disability type, diet quality, physical inactivity, caffeinated beverage consumption, daytime napping, screen time, caregiver-child relationship, and caregivers' age, race/ethnicity, education, and obesity status.

As shown in (Table 3) based on logistic regression models, compared with children who had ≥8 hours of sleep, children with short sleep duration <7 hours had high odds of general obesity (OR=3.28, 95% CI=0.96-11.2; P=0.058) defined by BMI ≥95th percentile and central obesity (upper quartile of body fat percentage) (OR=3.81, 95% CI=0.99-14.7; P=0.052). Further adjustment for covariates did not substantially change the results of short sleep duration with general obesity (P_{trend} =0.096) and central obesity (P_{trend} =0.048).

Further stratified analysis by children's disability type showed the similar results of the associations (data not shown in tables).

DISCUSSION

In this cross-sectional study of Chilean children with disabilities, the prevalence of general obesity was 31.2%. Adjusted means of obesity measures including BMI and body fat percentage varied by children's sleep duration, with the highest BMI and body fat percentage observed among children with objectively measured short sleep duration <7 hours. These associations were independent of other factors such as children's disability type, diet quality, physical activity, screen time, and caregivers' socioeconomic status and obesity status. To our knowledge, this is the first study to evaluate objectively measured sleep duration and its association with both general and central obesity measures including BMI and body fat percentage among Chilean children with disabilities.

Our findings of the high prevalence of obesity among children with disabilities are consistent with previous reports [2-5]. Short sleep has been increasingly recognized as a risk factor of adverse health outcomes including childhood obesity [14-16]. In this study, more than half of children (51.2%) had less than 8

Table 2: Linear regression models: associations between sleep duration and obesity measures among children with disabilities.

	BMI (kg/m^2)				Body fat percentage (%)			
	Unadjusted		Adjusted[a]		Unadjusted		Adjusted[a]	
	Beta (SE)	P value	Beta (SE)	P value	Beta (SE)	P value	Beta (SE)	P value
Sleep duration								
<7 hours	4.14 (1.42)	0.004	3.02 (1.32)	0.025	4.76 (2.61)	0.071	3.70 (2.71)	0.176
7-8 hours	1.07 (0.88)	0.226	0.38 (0.77)	0.618	2.79 (1.59)	0.083	1.87 (1.51)	0.220
≥ 8 hours	Reference		Reference		Reference		Reference	
Trend test		*0.007*		*0.064*		*0.028*		*0.108*

Abbreviations: BMI, body mass index; SE, standard error.
[a]Adjustment was made for children's age, sex, disability type, diet quality, caffeinated beverage consumption, physical activity, screen time, daytime napping, caregiver-child relationship, caregivers' age, race/ethnicity, education level, general obesity evaluated by BMI, and central obesity evaluated by waist-to-hip ratio.

Table 3: Logistic regression models: associations between sleep duration and obesity measures among children with disabilities.

	BMI (kg/m^2) ≥95th percentile[a]				High body fat percentage[b]			
	Unadjusted		Adjusted[c]		Unadjusted		Adjusted[c]	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Sleep duration								
<7 hours	3.28 (0.96, 11.2)	0.058	4.27 (0.81, 22.6)	0.088	3.81 (0.99, 14.7)	0.052	5.95 (0.90, 39.2)	0.064
7-8 hours	1.29 (0.57, 2.92)	0.549	1.51 (0.57, 4.02)	0.406	2.51 (0.99, 6.34)	0.052	2.42 (0.71, 8.20)	0.157
≥ 8 hours	Reference		Reference		Reference		Reference	
Trend test		*0.087*		*0.096*		*0.022*		*0.048*

Abbreviations: BMI, body mass index; CI, confidence interval; OR, odds ratio.
[a]Based on the US Centers for Disease Control and Prevention Growth Charts, 2000.
[b]The upper quartile of body fat percentage (32.2%) was used to define high body fat percentage.
[c]Adjusted for children's age, sex, disability type, diet quality, caffeinated beverage consumption, physical activity, screen time, daytime napping, caregiver-child relationship, caregivers' age, race/ethnicity, education level, general obesity evaluated by caregivers' BMI, and central obesity evaluated by caregivers' waist-to-hip ratio.

hours of sleep, and only 10% of children had sleep ≥9 hours. The majority of children with disabilities had insufficient sleep, given that the recommended amount of sleep for children aged 6-13 years is 9-11 hours per night [28]. Although sleep disturbances including short sleep are increasingly reported among children with disabilities, the inadequacy of current obesity intervention programs for this underserved population targeting sleep duration thus highlights the importance of our current findings that short sleep duration was associated with obesity measures among children with disabilities.

Research has increasingly documented the associations between sleep duration and obesity in the general pediatric populations [14-16]. The Cleveland Children's Sleep and Health Study of 819 US children aged 8-11 years found that parent-reported short sleep was significantly associated with child obesity [15]. A small study of 37 normal weight and 59 healthy overweight 10-year-old Chilean children reported that BMI was inversely related to overnight polysomnography-measured sleep duration [16]. In a 3-week experimental study with a crossover design among 37 children aged 8-11 years, Hart et al reported that increased sleep duration in school-age children was associated with lower measured weight [29], suggesting the potential role of increasing sleep duration in pediatric obesity prevention and weight management. To our knowledge, few studies have examined the associations between objectively measured sleep duration and obesity among children with disabilities. Our findings of the associations between short sleep duration and obesity measures in Patagonian children with disabilities support the limited body of literature and extend previous research in different pediatric populations [3,6,7,14]. This is a research area of high clinical and public health significance given the exceedingly high prevalence of obesity among children with disabilities [5-8]. Further research including longitudinal studies is warranted to examine the effect of sleep intervention programs on obesity among children with disabilities.

There are a variety of unhealthy lifestyle factors that have been related to childhood obesity, such as poor dietary quality, soft drinks, long screen time, and physical inactivity, as well as parental obesity [2,6,10-13]. The consumption of energy-dense foods and sugar-sweetened beverages has been related to the high prevalence of obesity [11]. Long screen time has been reported to be associated with child obesity [9]. Several researchers have reported significant associations of regular napping with lower BMI and body fat percentage among US adolescents with diabetes [30]. In this study, we controlled for these variables in our models. The persistence of the associations between sleep duration and general and central obesity measures in multivariable models suggests the relationships even after controlling for multiple putative confounders.

Our study has several notable strengths. First, we used both general and central obesity measures including BMI and body fat percentage among children living with disabilities, an understudied and at-risk population. Second, we incorporated caregivers' information on sociodemographic characteristics and obesity and controlled for their influences on the associations between sleep duration and child obesity measures. Third, we applied objective measurement of sleep duration (wrist actigraphy). Limitations of our study include a small sample size with relatively limited statistical power for multivariable analyses. The associations between sleep duration and obesity measures among children with disability seem complex and may be affected by unmeasured or residual confounding such as children's sleep disorders and stress. In addition, we used proxy-reported questionnaires to assess several confounders. The validity of actigraphy method has been criticized recently. Periods of quiet wakefulness may be interpreted by the device as sleep, and periods of restless sleep may be interpreted by the device as wakefulness [17,31]. Literature has indicated limitations of actigraphy for accurately capturing children's awakenings [32]. Despite this, actigraphy has been well validated for objective estimation of nocturnal sleep parameters across age groups in the natural sleep environment [18,33]. More research (e.g., longitudinal study design) is needed regarding the influence of caregiver chronic stress on child body composition, as well as on the interaction with lifestyle factors such as sleep traits among children with disabilities and their caregivers. We had no information on puberty for children. Given that this is a cross-sectional study, it is unclear what is behind the relationship between sleep duration and child obesity. It is not yet clear that lengthening sleep duration will significantly decrease the obesity prevalence among children with disabilities.

CONCLUSIONS

The prevalence of obesity was 31.2% among Patagonian children with disabilities. Children's short sleep duration was associated with great obesity measures including BMI and body fat percentage. Longitudinal studies are needed to infer the causality. Further research is warranted to examine the effect of sleep interventions on obesity in this underserved population.

ACKNOWLEDGMENTS

This research was supported by awards from the National Institutes of Health (National Institute on Minority Health and Health Disparities: T37-MD001449).

Funding

This research was supported by awards from the National Institutes of Health (National Institute on Minority Health and Health Disparities: T37-MD001449; PI: Michelle A. Williams).

The sponsor had no role in the design or conduct of this research.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent

Informed consent was obtained from all individual participants included in the study.

REFERENCES

1. World report on disability World Health Organization. 2011.
2. Maiano C. Prevalence and risk factors of overweight and obesity among children and adolescents with intellectual disabilities. Obes Rev. 2011; 12: 189-197.
3. Neter JE, Schokker DF, De Jong E, Renders CM, Seidell JC, Visscher TL. The prevalence of overweight and obesity and its determinants in children with and without disabilities. J Pediatr. 2011; 158: 735-739.
4. Lloyd M, Temple VA, Foley JT. International BMI comparison of children and youth with intellectual disabilities participating in Special Olympics. Res Dev Disabil. 2012; 33: 1708-1714.
5. Bandini LG, Curtin C, Hamad C, Tybor DJ, Must A. Prevalence of overweight in children with developmental disorders in the continuous national health and nutrition examination survey (NHANES) 1999-2002. J Pediatr. 146: 738-743.
6. Velez JC, Fitzpatrick AL, Barbosa CI, Diaz M, Urzua M, Andrade AH. Nutritional status and obesity in children and young adults with disabilities in Punta Arenas, Patagonia, Chile. Int J Rehabil Res. 2008; 31: 305-313.
7. Heitzinger K, Velez JC, Parra SG, Barbosa C, Fitzpatrick AL. Caregiver perceptions of child nutritional status in Magallanes, Chile. Obes Res Clin Pract. 2014; 8: e98-105.
8. Cairney J, Hay J, Veldhuizen S, Missiuna C, Mahlberg N, Faught BE. Trajectories of relative weight and waist circumference among children with and without developmental coordination disorder. CMAJ. 2010; 182: 1167-1172.
9. Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity: public-health crisis, common sense cure. Lancet. 2002; 360: 473-482.
10. McGillivray J, McVilly K, Skouteris H, Boganin C. Parental factors associated with obesity in children with disability: a systematic review. Obes Rev. 2013; 14: 541-554.
11. Hu FB. Resolved: there is sufficient scientific evidence that decreasing sugar-sweetened beverage consumption will reduce the prevalence of obesity and obesity-related diseases. Obes Rev.2013; 14: 606-619.
12. James J, Kerr D. Prevention of childhood obesity by reducing soft drinks. Int J Obes (Lond). 2005; 29 Suppl 2: S54-57.
13. Lee ST, Wong JE, Shanita SN, Ismail MN, Deurenberg P, Poh BK. Daily Physical Activity and Screen Time, but Not Other Sedentary Activities, Are Associated with Measures of Obesity during Childhood. Int J Environ Res Public Health. 2014; 12: 146-161.
14. Chen X, Beydoun MA, Wang Y. Is sleep duration associated with childhood obesity? A systematic review and meta-analysis. Obesity (Silver Spring). 2008; 16: 265-274.
15. Ievers-Landis CE, Storfer-Isser A, Rosen C, Johnson NL, Redline S. Relationship of sleep parameters, child psychological functioning, and parenting stress to obesity status among preadolescent children. J Dev Behav Pediatr. 20018; 29: 243-252.
16. Chamorro R, Algarin C, Garrido M, Causa L, Held C, Lozoff B, et al. Night time sleep macrostructure is altered in otherwise healthy 10-year-old overweight children. Int J Obes (Lond). 2014; 38: 1120-1125.
17. Sadeh A, Acebo C. The role of actigraphy in sleep medicine. Sleep Med Rev. 2002; 6: 113-124.

18. Martin JL, Hakim AD. Wrist actigraphy. Chest. 2011; 139: 1514-1527.

19. Hvolby A, Jørgensen J, Bilenberg N. Actigraphic and parental reports of sleep difficulties in children with attention-deficit/hyperactivity disorder. Arch Pediatr Adolesc Med. 2008; 162: 323-329.

20. Chen X, Gelaye B, Velez JC, Pepper M, Gorman S, Barbosa C, et al. Attitudes, beliefs, and perceptions of caregivers and rehabilitation providers about disabled children's sleep health: a qualitative study. BMC Pediatr. 2014; 14: 245.

21. Chen X, Velez JC, Barbosa C, Pepper M, Andrade A, Stoner L, et al. Smoking and perceived stress in relation to short salivary telomere length among caregivers of children with disabilities. Stress. 2015; 18: 20-28.

22. Chen X, Gelaye B, Velez JC, Barbosa C, Pepper M, Andrade A, et al. Caregivers' hair cortisol: a possible biomarker of chronic stress is associated with obesity measures among children with disabilities. BMC Pediatr. 2015; 15: 9.

23. ActiLife 6. ActiLife, ActiGraph R&D. 2014.

24. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM, Flegal KM, Guo SS, Wei R, et al. CDC growth charts: United States. Adv Data. 2000; : 1-27.

25. Acebo C, Sadeh A, Seifer R, Tzischinsky O, Wolfson AR, Hafer A, et al. Estimating sleep patterns with activity monitoring in children and adolescents: how many nights are necessary for reliable measures? Sleep. 1999; 22: 95-103.

26. International Classification of Diseases (ICD-10). ICD-10 International Statistical Classification of Diseases and Related Health Problems. 10th Revision. 2010; 2.

27. [No authors listed]. Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults--The Evidence Report. National Institutes of Health. Obes Res. 1998; 6 Suppl 2: 51S-209S.

28. Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, Doncarlos L, et al. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. Sleep Health. 2015; 1: 40-43.

29. Hart CN, Carskadon MA, Considine RV, Fava JL, Lawton J, Raynor HA, et al. Changes in children's sleep duration on food intake, weight, and leptin. Pediatrics. 2013; 132: e1473-1480.

30. Estrada CL, Danielson KK, Drum ML, Lipton RB. Insufficient sleep in young patients with diabetes and their families. Biol Res Nurs. 2012; 14: 48-54.

31. Johnson KP, Giannotti F, Cortesi F. Sleep patterns in autism spectrum disorders. Child Adolesc Psychiatr Clin N Am. 2009; 18: 917-928.

32. Meltzer LJ, Walsh CM, Traylor J, Westin AM. Direct comparison of two new actigraphs and polysomnography in children and adolescents. Sleep. 2012; 35: 159-166.

33. De Crescenzo F, Licchelli S, Ciabattini M, Menghini D, Armando M, Alfieri P, et al. The use of actigraphy in the monitoring of sleep and activity in ADHD: A meta-analysis. Sleep Med Rev. 2015; 26: 9-20.

Cite this article

Chen X, Whittier A, Velez JC, Barbosa C, Pepper M, et al. (2016) Actigraphy-Measured Sleep Duration in Relation to General and Central Obesity in Patagonian Children with Disabilities. J Sleep Med Disord 3(1): 1037.