Sleep Duration and Obesity of Young Mexican-heritage Children in Rural California

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Citation: Schaefer SE, Gomez-Camacho R, Muñoz-Gomez M, et al. Sleep Duration and Obesity of Young Mexican-heritage Children in Rural California. J Child Obes 2017, 2:5.

Abstract

Background: Short sleep duration may contribute to obesity and metabolic disease. The objective of this study was to characterize how sleep duration was associated with childhood obesity in two rural Mexican-heritage communities in California.

Methods: Data were collected from children 4-8 years of age (N=148) in two rural communities in California. Trained staff conducted family demographic surveys and child anthropometric measurements. Continuous physical activity and sleep data were collected via a wrist-worn accelerometer for one week. Nightly sleep duration was examined among preschool (4-5 years) and school age (6-8 years) children against measures of weight status and BMI.

Results: The majority of children (95%) measured in this study appeared to fall short of recommended sleep times. The mean duration of nightly sleep among children was 8.3 hours. Among children 6-8 years of age, sleep duration was marginally shorter among overweight/obese children compared to children of normal weight. Multiple regression showed body mass index percentile was negatively associated with sleep duration, among children whose families had been longer in the United States (p=0.015, R^2=0.1352).

Conclusion: Promoting longer sleep may be an important part of weight gain prevention once children reach school age, especially in Latino communities where acculturation is an additional risk factor for obesity.

Abbreviations:

AOS: American Oriented Scale; BMI: Body Mass Index; CBPR: Community Based Participatory Research; CDC: Centers of Disease Control and Prevention; MOS: Mexican Oriented Scale; MVPA: Moderate-to-Vigorous Physical Activity; NSF: National Sleep Foundation; NSFS: Niños Sanos, Familia Sana; UCD: University of California, Davis

Keywords: Sleep duration; Childhood obesity; Latino health; Community; Intervention; Acculturation; Health behaviour

Introduction

One in three children in the United States is overweight or obese and at-risk for metabolic or cardiac disease [1,2]. Modifiable lifestyle risk factors such as physical activity and diet are common targets of intervention [3-5]. Inadequate or restricted sleep is another modifiable lifestyle variable linked to obesity among other negative health conditions such as diabetes, heart disease and depression [6-15]. It is therefore concerning that sleep inadequacy affects 15 million American children, six million at a moderate or severe level [16]. The National Sleep Foundation (NSF) recommends 9-11 hours of sleep each night for children (6-13 years) and 10-13 hours for pre-schoolers (3-5 years) [16]. Promoting adequate sleep may be an important component to consider in childhood obesity prevention [17,18].

Prevalence of childhood obesity is disproportionate among certain segments of the population [1,19,20]. Latino communities in the U.S. carry one of the highest burdens of childhood obesity attributable to a complex interplay of socioeconomic, environmental and genetic factors. Nearly half of Latino children (46% of 6-11 years olds) are affected which is more than any other ethnic group [1,19,20]. Underserved populations stand to benefit from health interventions that target modifiable factors. Disparities in lifestyle variables like diet, activity and sleep have been documented between ethnic groups highlighting the importance of culturally appropriate approaches [21-24].

Mexican-heritage communities located in California's agriculturally productive Central Valley region have childhood obesity rates above the national average. This is a concerning health burden for this economically viable region [24]. While culturally appropriate interventions are needed, relatively little is known about the complex interplay of risk factors in these rural, hard-to-reach, culturally nuanced communities. This

information is essential to inform community and family based health interventions for at-risk children in this region. Hence, the objectives of this paper are multifold, and include a) examining sleep duration in preschool and school age children in an at-risk population, b) exploring associations with weight status, and c) exploring the influence of cultural, socioeconomic, and demographic variables.

Methods

The study was conducted in two Central Valley towns, Firebaugh and San Joaquin, located in Fresno County, California. These towns are demographically and geographically similar; both are rural, have a population that is over 90% Mexican-heritage with a primarily agricultural employment base [24,25]. Community members in both towns are largely monolingual Spanish speaking, immigrants with low income and very low educational levels, and rely on seasonal employment [24]. All age-eligible (3-8 years) children were recruited for this study, independent of ethnic/racial status since in both towns over 90% of the children are Mexican-heritage. The development of the Ninos Sanos Familia Sana (Healthy Children, Healthy Family) childhood obesity prevention program and methodology are published in detail elsewhere [24]. Briefly, NSFS used community-based participatory research (CBPR) to cultivate local partnerships in target communities to enhance participant recruitment, intervention delivery, data collection and program adherence. A local advisory committee was organized and met quarterly to review study progress and provide feedback. Also, local Spanish-speaking promotores (lay workers or promoters) were hired to help with family recruitment, community-wide events and intervention delivery. Approval for this research was granted by the Institutional Review Board at the University of California, Davis (UCD). Parents or legal guardians signed informed consent forms in their preferred language (Spanish or English).

Of 971 children assessed for eligibility to participate in NSFS, 68 did not meet inclusion criteria and 121 were not interested in participating. Anthropometric measurements of weight, height, abdominal circumference and skinfold thickness (triceps and subscapular) were collected on all NSFS eligible children from April 2012 through January 2013. To obtain anthropometric measurements of children and families in this hard to reach community, a variety of methods were used to collect data during community events, health fairs, home visits and field office appointments. A calibrated digital scale (Seca 874) was used to weigh participants to the nearest 0.1 kg. A portable stadiometer (Seca 213) was used to measure height in centimeters (cm) to the nearest 0.1 cm. Abdominal circumference was obtained by using a body circumference measuring tape (QuickMedical QM2000). Finally, skinfold thickness of the triceps and subscapular regions were measured using Lange calipers (Beta Technology, Santa Cruz, CA). Local staff and UCD students were trained and standardized to collected the measurements in duplicate following procedures described in the Anthropometric Standardization Reference Manual (26). Prior to measurement, children were asked to remove shoes and heavy clothing (i.e., sweatshirts, jackets).

Child body mass index (BMI), age and sex specific percentile, and z-score were calculated using guidelines from the Centers of Disease Control and Prevention (CDC). Children were categorized by BMI percentile as normal, (BMI<85th percentile), overweight (BMI ≥ 85th percentile) or obese (BMI ≥ 95th percentile) [26-28].

Trained bilingual staff interviewed parents to collect demographic and economic data, including several acculturation variables (i.e., primary language, years in the U.S.). Interviews were conducted in Spanish or English depending on the participant's primary language. An acculturation score was generated through administration of a modified 12-item Cuellar acculturation survey measuring Mexican oriented behavior (MOS) and Anglo oriented behavior (AOS) [27]. The total score is calculated (acculturation score=AOS-MOS), ranging from 4 (full-oriented Anglo behavior) to -4 (full-oriented Mexican behavior).

Child sleep duration was assessed with data from PolarActive^{TM}, a wrist worn accelerometer used to assess physical activity as a primary measure in this study. A subsample of NSFS children between ages 4-8 years were targeted for physical activity measurement. A protocol for was developed and tested in a nearby community with similar sociodemographic and cultural characteristics [29,30]. During the months of April through August 2012, collaborative strategies were organized between researchers, field staff, school staff and promotores (local health workers) to target age eligible NSFS children during community events, health fairs, home visits, field office appointments, etc. Children were asked to use the device for nine consecutive days, allowing for the collection of up to seven 24-hour periods. Each child and parent(s) was verbally instructed to not remove the device while bathing or sleeping. At the end of the scheduled collection period, parents were asked to return the device to the field office located in Firebaugh. Alternatively, program staff retrieved the device from participants' homes. Of 206 children approached for this component, only 2 declined to participate. Of 204 devices distributed, 148 cases were used in the final analysis. Missing cases resulted from device loss or malfunction (N=39). For the majority of children (N=122), seven 24-hour periods were captured. Valid days were defined where at least 20 hours were captured within a 24-hour period. Cases with less than 3 valid days were also excluded from final analyses (N=17). PolarActive^{TM} assesses physical activity via continuous measurement of time in five intensity zones, and estimates of daily step count and energy expenditure. Sleep time is an algorithmic extrapolation of daily active time. The development and validation of this device have been described in a manufacturer publication showing physical activity measurement to have high correlation with oxygen consumption measurement in children (R=0.93) [31]. Physical activity data are presented elsewhere but explored in these analyses as a confounding variable.

In addition to measures of child anthropometry, sleep duration and physical activity, data included a set of individual, social and environmental variables used as correlates to contextualize and control for various characteristics. Individual and family characteristics included child gender, age, number of

siblings, sibling order, mother's demographics (age, education, work status, the number of years in the United States, and BMI), father in the household, primarily language spoken at home, and acculturation score. Statistical analyses were conducted in Stata Statistical Software Version 11 (StataCorp 2009 College Station, TX). Variables including sleep duration, MVPA, sedentary activity and BMI were tested using independent t-tests to detect differences between gender and weight status. Averages were adjusted the number of days/nights measured for each child. Data on sleep duration were used to create categories of children who, on average, achieved adequate or inadequate sleep. To define the cutoff for adequate sleep, researchers used the minimum NSF recommendation per age group for children in the sample (540 minutes (9 hours)/night for children >6 years, 600 minutes (10 hours)/night for <5 years) [16]. Differences in the percentage of children who achieved low and adequate sleep time in the normal and overweight/obese groups were tested using a chi-square test. Multivariable linear regression with a backwards stepwise selection method was used to create a model where child sleep duration was associated with BMI and other confounding individual, family and/or environmental characteristics.

Results

This paper presents data from a subsample of Mexican-heritage children (N=148) with an average age of 6.8 years (47% boys and 53% girls). Approximately 95% of children in this sample were from Mexican-heritage families and born in the U.S. More than half of child participants were Spanish speaking (54%). The demographic and socioeconomic characteristics of parents are presented in Table 1. The average acculturation score of families included in this sample was -2.3 (+1.5), indicative of a 'traditional' orientation. A mother's average education level ranged from 8.2-9.2 years, indicating that most parents did not complete high school.

Table 1: Parent demographic and socioeconomic characteristics.

Variable	Mean (SD)	
	Mother (N=123)	Father (N=107)
Age (years)	34.9 (6.5)	38.3 (7.1)
# of children	2.9 (1.2)	----
Age at birth of first child (years)	23.8 (5.2)	----
<20 years at birth of first child	31%	----
Acculturation variables		
Mexican heritage	95%	97%
Born in Mexico	86%	85%
Years living in U.S.	15.1 (7.6)	19.5 (8.3)
Age (years) when entered U.S.	19.9 (8.5)	18.7% (8.3)
Primary language Spanish	82%	77%
Education variables		
Years of education	9.2 (3.8)	8.2 (3.7)
Education in Mexico	67%	72%
Socioeconomic variables		
Occupation 'homemaker' or unemployed	65%	58%
Has health insurance	55%	53%
# cities of residence in last 5 years	1.4 (1.3)	1.3 (0.5)

Measured variables of children's weight status, sleep duration and physical activity patterns are presented in Table 2. Children were classified on the basis of age and sex-adjusted body mass index as normal weight (55.4%); overweight (19.3%); or obese (25.3%). The mean overall duration of nightly sleep was 8.3 hours. Data were grouped by age in accordance with the National Sleep Foundation's recommendations for preschool (10-13 hr/night) and school age (9-11 hr/night) children. Sleep duration was different between age groups, and as expected was higher in younger children compared to older (8.4 and 8.0 hrs/night, respectively; P=0.017). Our data suggest that approximately 5% of children (N=7) in this population meet these recommendations on average. There were no gender-related differences in sleep duration overall, nor between age groups. However, among older children, sleep duration was

marginally less among overweight/obese children compared to children of normal weight (P=0.072).

Table 2: Measured variables of child obesity, sleep and physical activity patterns (N=148).

	4-5 years (N=80) Mean (SD)			6-8 years (N=68) Mean (SD)		
	Normal	**Overweight/obese**	**p-value**	**Normal**	**Overweight/obese**	**p-value**
Gender	20 male 22 female	18 male 20 female	----	14 male 30 female	15 male 9 female	----
Sleep duration (min/night)	499.62 (56.71)	495.49 (47.50)	0.749	486.96 (27.82)	469.92 (39.79)	0.072
MVPA (min/day)	76.36 (29.92)	77.66 29.08	0.857	83.05 (25.43)	74.64 (32.86)	0.229
Sedentary (min/day)	863.80 (55.23)	866.36 61.90	0.857	870.09 (36.30)	882.37 (55.91)	0.337
Obesity measures						
BMI z-score	0.20 (0.74)	1.72 (0.60)	----	0.09 (0.79)	1.65 (0.47)	----
BMI percentile	58.84 (24.08)	94.82 (4.33)	----	54.07 (23.04)	93.64 (4.56)	----
Abdominal circumference	51.27 (5.62)	59.36 (4.87)	----	53.56 (6.91)	64.37 (10.66)	----
Subscapular skinfold thickness	6.31 (1.63)	11.62 (6.29)	----	6.69 (1.82)	12.82 (5.77)	----
Triceps skinfold thickness	10.04 (3.22)	14.60 (4.72)	----	10.83 (3.43)	15.67 (5.49)	----

According to the CDC guidelines for BMI, 55% of children in this sample were considered normal and 45% were either overweight or obese. Independent student t-tests showed no gender differences in obesity measures including BMI and skin fold measurements. Results from the analyses of physical activity data are described in detail elsewhere and not the focus of this paper. Briefly, this population of children engaged in 78.7 min/day of MVPA and 14.4 hr/day of sedentary activity overall [30]. MVPA was different for boys and girls (85.54 and 72.31 min/day, respectively; p=0.008). MVPA was not different between the age groups defined in these analyses.

Multivariate backwards stepwise regression was used to create a model dependent on child BMI, to examine the impact of sleep duration, tested with a number of socioeconomic and environmental variables (i.e., household size, income, parent education, acculturation). BMI-z-score revealed no significant influence of sleep duration. It was found that increased BMI percentile was associated with shorter sleep duration in for children whose families had been in the U.S. for longer (P=0.015; R^2=0.1352).

Discussion

Our results show that Mexican-heritage children in this sample obtained an average nightly sleep of just over 8 hours,

and the majority fell short of NSF recommendations. School age children with elevated BMI (overweight and obese) had a marginally lower average nightly sleep duration than those of normal weight. Such patterns weren't evident among preschool age children (4-5 years). Although marginal, these results may suggest that upon reaching school age, short sleep duration may begin to influence child weight gain. More research is needed in samples of larger sizes and power to confirm these results. If true, this indicates the importance of promoting adequate sleep as children approach school age. Sleep duration was different between boys and girls in this study, which may be attributable to the younger age of the sample; other literatures suggest gender differences emerge later in childhood or adolescence [32].

These findings contribute to the growing body of literature demonstrating a negative association between sleep duration and BMI among children [33-38]. While underlying physiological mechanisms are not well understood, clinical evidence suggests hormonal and neural regulation may be altered from inadequate sleep [4,39,40]. In the present communities where childhood obesity rates are above the national average, nearly all children measured obtained an average nightly sleep for less than age-based recommendations. Metabolic health consequences of restricted or inadequate sleep are well documented in adults [39,40], and are potentially more concerning in developing

children as the impacts can be lifelong. The impacts of short sleep duration extend beyond metabolic health and have been directly correlated to performance on neurocognitive function [33,36] (Table 3).

Table 3: Multivariate regression analysis of the association between sleep duration and overweight/obesity among children 4-8 years (N=108)

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std Error	Beta		
Constant	131.697	35.892		3.669	0
Sleep	-0.114	0.057	-0.202	-1.998	0.049
MVPA	0.063	0.096	0.066	0.654	0.515
Age	-3.721	2.598	-0.145	-1.432	0.155
Gender	-3.125	5.392	-0.059	-0.58	0.564
Years in US	1.031	0.378	0.274	2.725	0.008
Dependent variable: BMI percentile; P=0.015; R2=0.1352					

This study expands on the currently limited body of literature of sleep patterns in Latino communities, particularly of Mexican heritage. Latino children suffer the highest obesity rates in the country and are at increased risk for lifelong metabolic illness [1]. At least one other study has shown that Mexican American children with shorter sleep duration are more likely to increase weight status over time [23]. Hence it seems important to target sleep in childhood obesity interventions in these communities. Numerous social and environmental variables were examined in regression for a confounding impact on weights status and sleep but most did not have significant influence. The acculturation variable 'years in US' had a significant impact on BMI percentile, indicating that longer time living in the U.S. is also a risk factor for health of these families and children. While the influence of acculturation on metabolic health in Latino communities is not new, our findings suggest that sleep patterns of children in more acculturated households may exacerbate health risks. This adds to a limited body of evidence that acculturation to the U.S. lifestyle leads to worse sleep habits in Hispanics [37].

Given the important role that adequate sleep is shown to play in health and development, the prevalence of short sleep duration in this population is concerning and should be targeted in intervention programs. Although outside the scope of the present work, there are a few studies that elaborate on specific behaviors impacting sleep that may be useful to researchers, health educators and policy makers developing and evaluating efforts to prevent obesity in Latino communities. Studies have suggested that delayed bedtime and early school start times are contributing factors to insufficient sleep in youth. Also, television viewing has been shown to interfere with sleep; children who sleep more during the night are less likely to watch TV before bed compared to those who read before bed [38]. Further, children with televisions in their bedroom or who watch TV before bed are more likely to have a later bedtime [6,37]. Other research has also identified a positive association between obesity and having varied sleep patterns between weekend and weekday [22,38]. We observed longer sleep duration in preschool compared to school age children, which is expected as child sleep duration naturally decreases with age. It might also be valuable to explore if this pattern could also be connected to a child's transition from preschool to grade school, and how that transition can be smoothed to support adequate sleep.

This study was limited by sample size. Inclusion of a greater number of children in the sample may have enhanced the statistical power and significance of results. Also because few children were determined to be meeting recommendations it was difficult to make comparisons to those who do meet sleep needs. A contribution of this study is the use of a commercial accelerometer technology to generate useful sleep data in this population. Compliance is often a barrier to accurate measurement using wearable electronic devices in field studies, especially among children. Data were successfully collected on 72% of children asked to use the device; considering the study population is hard-to-reach in terms of socioeconomic, geographic, cultural and linguistic barriers, this rate is higher than expected. This favorable compliance rate is likely attributable to the study's CBPR approach which improved the reach of data collection by using a combination of family and community level strategies.

Conclusion

Short sleep duration in this population of Mexican-heritage children was found to be highly prevalent. Short sleep may influence weight gain in school age children. We suggest child obesity interventions c sleep time in addition to adequate physical activity and nutritious diet, especially in Latino communities where acculturation is a risk factor.

Acknowledgements

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