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Mother-reported sleep, accelerometer-estimated sleep, and weight status in Mexican American children: Sleep duration is associated with increased adiposity and risk for overweight/obese status

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Summary

We know of no studies comparing parent-reported sleep with accelerometer-estimated sleep in their relation to pediatric adiposity. We examined: 1) the reliability of mother-reported sleep compared with accelerometer-estimated sleep, and 2) the relationship between both sleep measures and child adiposity. The current cross-sectional study included 304 Mexican American mother-child pairs recruited from Kaiser Permanente Northern California. We measured sleep duration, using maternal report and accelerometry, and child anthropometrics. Concordance between sleep measures was evaluated using the Bland-Altman method. We conducted zero-ordered correlations between mother-reported sleep, accelerometer-estimated sleep and child BMI z-scores (BMIz). Using linear regression, we examined three models to assess child BMIz with mother-reported sleep (model 1), accelerometer-estimated sleep (model 2), and both sleep measures (model 3). Children had an average age of 8.86 years (SD= .82). Mothers reported that their child slept 9.81 ± 0.74 (95% CI: 9.72, 9.89) hours, compared to 9.58 ± 0.71 (95% CI: 9.50, 9.66) hours based on accelerometry. Mother-reported sleep and accelerometer-estimated sleep were correlated ($r = 0.33$, $p < 0.001$). BMIz outcomes were negatively associated with mother-reported sleep duration (model 1: $\beta = -0.13$; $P = .02$) and accelerometer-estimated sleep duration

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(model 2: β = −0.17; P < .01). Accounting for both sleep measures, only accelerometer-measured sleep was related to BMIz (model 3: β = −0.14, P = .02). Each sleep measure was significantly related to adiposity, independent of covariates. Accelerometry appeared to be a more reliable measure of children's sleep than maternal report, yet maternal report may be sufficient to examine the sleep-adiposity relationship when resources are limited.

Keywords

sleep measurement; parental report; accelerometer; pediatric obesity; Mexican-American; child

INTRODUCTION

Given the global rise in pediatric obesity as well as the increase in short sleep duration among children and adolescents, recent investigations have examined the association between sleep and adiposity in this population. Identifying the underlying factors that may contribute to the development of overweight and obesity during childhood years is imperative, given that obesity is an independent risk factor for lifelong obesity and metabolic dysfunction, including insulin resistance, type 2 diabetes and inflammation, which are disproportionate among Latino children (Skinner et al., 2010, de Ferranti et al., 2006). Moreover, research has found that Latino children are more likely to have an irregular bedtime and/or have a bedtime after 9 PM in comparison to non-Latino white children (Owens and Jones, 2011). Further research is needed to identify points of prevention and intervention, particularly among Latino youth, who are disproportionately affected by obesity and metabolic disturbances (Ogden et al., 2010).

Recently, short sleep duration has been described as a risk factor for childhood overweight and obesity. Two separate meta-analyses of cross-sectional studies reported that short sleep duration was consistently related to increased adiposity in children (Chen et al., 2008, Cappuccio et al., 2008). Of these studies, most investigations utilized parental and/or child reports of sleep. Few studies have used accelerometer-estimated sleep to examine the relationship between sleep duration and child adiposity (Colley et al., 2012, Chaput et al., 2011, Gupta et al., 2002, Nixon et al., 2008). Of these studies, Gupta and colleagues (2002) found that for every hour of sleep loss, the odds of obesity increased by 80 percent in U.S. adolescents (n = 383). Chaput et al. (2011) found a U-shaped relationship between sleep duration and adiposity in Canadian 8- to 10-year-olds (n = 550) and Colley et al. (2012) did not find any association. Nixon et al. (2008) found that sleep sleeping less than 9 hours was independently and related to obesity in a cross-sectional study of Australian children at age 7. Furthermore, several longitudinal studies have been conducted, but have yielded inconsistent findings (Araujo et al., 2012, Eisenmann et al., 2006, Tatone-Tokuda et al., 2012, Touchette et al., 2008, Lumeng et al., 2007, Agras et al., 2004). Of these studies, three studies supported the findings of cross-sectional studies (Touchette et al., 2008, Agras et al., 2004, Lumeng et al., 2007); three studies reported that sleep mattered more in the development of overweight or obesity in boys than girls (Eisenmann et al., 2006, Tatone-Tokuda et al., 2012); and one study reported that sleep did not significantly predict adiposity in boys or girls (Araujo et al., 2012). These studies were based on parent- or self-reported sleep, which may explain some of the differences in findings given that reports may have been representative of the time to bed as opposed to sleep onset. Because sleep onset is variable, subjective reports of sleep, whether by parent or child, may be less reliable and result in an overestimation of sleep duration (Holley et al., 2009). However, whether parent-reported sleep is sufficiently reliable to examine the relationship between sleep and child adiposity has yet to be established. In contrast, accelerometry is becoming recognized as a method of sleep assessment useful for epidemiological purposes (Hjorth et al., 2012). One study used accelerometry to estimate sleep duration and found a consistent relationship between sleep and obesity in both adolescent males and females (Lytle et al., 2011). A comparison study of parent-reported sleep duration and accelerometer-estimated sleep duration and their relation to pediatric adiposity could be beneficial given the state of the budget and limited funds to assess sleep using more costly objective methods compared with cost-effective parental report.

To our knowledge, three studies have compared parent-reported sleep with objectively measured sleep in 6- to 11-year-olds (Colley et al., 2012, Holley et al., 2009, Nixon et al., 2008). In one study (UK; n = 91), investigators did not examine the relationship between sleep and adiposity (Holley et al., 2009). In the second study (Canada, n = 878), researchers did not compare the reliability of parent-reported sleep with accelerometer-estimated sleep, nor did they detect a relationship between sleep and adiposity, using both sleep measures (Colley et al., 2012). In the third study, sleep duration estimates were compared between parental-report and accelerometry, but they did not examine the relationship between parental reported sleep and adiposity. To address these gaps in the literature, the purpose of this study was threefold. First, we examined the reliability of retrospective parent-reported sleep duration, compared with an objective measure of sleep duration in a sample of Mexican American children. Second, we assessed the cross-sectional relationship between both retrospective parent-reported and objectively measured sleep and children’s weight status, while controlling for potential covariates (i.e., maternal BMI, occupation, acculturation, child pubertal status). Lastly, we explored whether or not there was a sleep-gender interaction in the relationship with BMI status.

METHODS

Participants and Data Collection

We recruited 326 families who were members of Kaiser Permanente Northern California, an integrated health care delivery organization. Parents were sent letters introducing the research, were telephoned, screened for eligibility, and invited to participate in the study. Parent-child pairs were eligible if: 1) the mother was of Mexican origin (born in the US or Mexico), 2) the child was 8–10 years of age, and 3) the child had no major illnesses. Bilingual interviewers obtained parental informed consent and child assent to participate in the research. They interviewed parent-child pairs in their homes in the participants’ preferred language. Twenty-two mother-child pairs who were missing data on children’s sleep, height or weight were excluded from the study, resulting in final sample of 303 mother-child pairs. The study was approved by the University of California San Francisco and Kaiser Permanente Northern California Research Foundation Institutional Review Boards.

Measure Development

All study measures were translated into Spanish and reviewed side-by-side by a bilingual committee. Translations were compared for equivalent meaning, and items were revised or decentered as needed (Marin and VanOss Marin, 1991). Decentering is a process in which both languages are considered equally important, and either language may be altered to obtain linguistically equivalent items.

Study Measures

Mother-reported sleep duration (retrospective)—We assessed children's sleep duration with two items used in previous research. Mothers were asked, "What time does (child) usually go to sleep at night?" and "What time does (child) usually wake up in the morning?" From these responses, the child's usual sleeping time was calculated. No distinction was made between weekday and weekend nighttime sleep duration.

Accelerometer-estimated sleep duration—Sleep duration was assessed consecutively for two week nights and 1 weekend night. Three days was chosen to reduce participant burden and maximize study participation. Children's free-living activity was recorded for three consecutive days (two week days, one weekend day) using the Actical accelerometer (Philips Respironics, Bend, OR). Actical contains an omnidirectional accelerometer built from a cantilevered rectangular piezo-electric bimorph plate and seismic mass, which is sensitive to movement in all directions. The piezo-electric sensor is oriented in the Actical such that maximum sensitivity is obtained when the center of body mass is moved against gravity. When positioned on the hip, the device is most sensitive to vertical movements of the torso. Actical is sensitive to movements in the 0.5–3 Hz range, allowing for detection of sedentary movements as well as high-energy movements. Actical's frequency range minimizes the effect of undesirable noise impulses, which tend to skew results.

Each accelerometer was programmed to collect data at 1-minute intervals at a specified start time. The monitor was attached to an elastic belt with an adjustable buckle, and positioned on the child above the iliac crest of the right hip. Research assistants provided verbal and written instructions for care and placement of the monitor and belt at the time of the home visit. The child was instructed to wear the monitor at all times for three consecutive days, except during bathing. Accelerometers were collected after the third day.

Nighttime sleep duration was determined as the mean of the three 24-hour accelerometer measurements. To minimize inter-interpreter variation, a single trained research assistant conducted visual inspections. A plot of activity counts per minute for each 24-hour period was used to identify the time of sleep onset and termination. The nighttime sleep period lasts about 10 hours during which the activity counts are usually zero. Sleep periods were cross-checked with the participants' wear log for "off" times. Stretches of 20 minutes of zeroes without being explained as sleep were considered "off". Any minutes scored as awake were removed from the sleep duration. Sleep duration measured by hip-worn accelerometry has been found to be highly correlated (r = 0.93) with sleep duration measured with a wrist-worn accelerometer in children aged 10 to 11 years (Kinder et al., 2012).

Meeting the 10 hour sleep recommendation—Using mother-reported and accelerometer-estimated sleep duration variables, we created two categorical sleep variables according to the National Sleep Foundation's (NSF) 10 hour sleep recommendation for 5- to -12-year-olds.(National Sleep Foundation) Children were categorized as meeting the 10 hour sleep recommendation (≥10 hours = 1; reference group) and not meeting the 10 hour recommendation (< 10 hours = 2).

Body Mass Index (BMI)—Trained research assistants measured child height and weight using standard procedures (Stallings and Fung, 1999). Height and weight were measured in duplicate while the participant was wearing light indoor clothing and no shoes. BMI was calculated (BMI = weight[kg]/height[m]^2), converted to age- and gender-specific percentiles, and converted to z-scores using CDC growth charts. Based on BMI percentiles, children were also classified as underweight (<5th percentile), normal weight (≥5th to <85th percentile), overweight (≥85th to <95th percentile), or obese (≥95th percentile). For the linear regressions, we used children's BMI z-scores (BMIz). For logistic regressions, we classified children as normal (<85th percentile = 1) vs. overweight/obese (≥85th percentile = 2).

Pubertal Status—We used the 5-item Pubertal Development Scale to assess pubertal status (Petersen et al., 1985), which was completed by mothers. This measure, with versions for males and females, asks about physical development on characteristics associated with physical maturation (growth spurt, body hair, skin change, breast development, menarche, voice changes), with responses ranging from no [1] to yes, a lot [3]. A single score representing the mean of the scale items was obtained.

Covariates—Demographic variables included child age and gender and maternal characteristics, including BMI, years of education, occupational status and acculturation. Mothers' height and weight was measured and BMI was calculated: BMI < 25 (normal weight); BMI: 25 – 29.9 (overweight); BMI ≥ 30 (obese). Occupational status ranged from lowest (1 = unskilled) to highest (9 = professional) (Hollingshead, 1975). Mother's acculturation was assessed using the Spanish and English Language Use subscales of the Bidimensional Acculturation Scale for Hispanics (Marin and Gamba, 1996). For example, Spanish subscale items included: *how often do you speak Spanish; how often do you think in Spanish; how often do you speak Spanish at home with your family?* Items are scored from never (=1) to always (=5), and subscales had good reliabilities in this sample (α = .88 – .94).

STATISTICAL ANALYSES

The results of the two sleep measurements (mother-reported and accelerometer-estimated sleep) were analyzed by means of descriptive statistics (median, mean, and standard deviation). The Pearson correlation coefficient was used to estimate between mother-reported and accelerometer-estimated sleep. In addition, we estimated Pearson correlations between the sleep variables and child BMI z-scores. A Bland and Altman plot with 95% limits of agreement was calculated as a measure of agreement between (and within) the instruments (Bland and Altman, 1986). This approach allowed individual comparisons between mother-reported sleep and accelerometer-estimated sleep by examining a plot of the differences in sleep duration by maternal report and accelerometry versus mean sleep duration by both measurements. To evaluate the presence of a systematic bias, we performed a regression analysis of the difference in sleep duration by maternal report and accelerometry on mean sleep duration. Paired t-tests were performed to determine differences between the mean values obtained with maternal report and accelerometry and to compare nighttime sleep duration during the week (mean of two nights) versus the weekend (one night).

We also conducted correlations to assess which demographic variables and covariates were related to child BMI, and therefore should be included in multivariate analyses. Next, we conducted three multiple regressions, examining child BMI z-scores with (1) mother-reported sleep, (2) accelerometer-estimated sleep, or (3) both mother-reported and accelerometer-estimated sleep. Each regression equation included the demographics and covariates that had been significantly related to child BMI in the correlations. Finally, we conducted secondary analyses to test whether not meeting the NSF's 10 hour sleep recommendation was a risk factor for being overweight or obese. We conducted three multiple regressions, examining overweight/obese status with (1) mother-reported sleep, (2) accelerometer-estimated sleep, or (3) both mother-reported and accelerometer-estimated sleep. We used SPSS, Version 20 (SPSS Inc, Chicago, IL) to perform all analyses at $p < .05$.

RESULTS

Sample Characteristics

Descriptive statistics for mother-child pairs are included in Table 1. Participating children were ages 8–10 (M = 8.86 years, SD = .82), 53% female, and 95% U.S. born. Nearly half of the children were overweight (20%) or obese (28%). Mothers had about 11 years of education, 75% were employed, and the average occupation was being a skilled worker (M = 3.23; SD = 2.03). Most mothers chose to be interviewed in Spanish (71%).

Forty-eight percent of mothers reported that their child slept at least 10 hours compared with accelerometer data showing that 26% of children slept at least 10 hours (Table 1). As shown in Table 2, mother-reported sleep duration was an average of 9.81 hours/night (SD = .74; median =10.0; 95% CI: 9.72, 9.89) compared with accelerometer-estimated sleep duration, which was an average of 9.58 hours/ night (SD = .71; median = 9.55; 95% CI: 9.50, 9.66); t [302] = 4.43). The difference in mean values was statistically significant (P < .001). On average, mothers reported that their child slept 0.22 hours (SD = 0.87 [CI: 0.12, 0.32]) more (equivalent to 13 minutes) compared with the accelerometer-estimated sleep duration. In addition, the paired *t*-test showed that children slept slightly more on the weekend (9.84, SD = 1.25 [CI: 9.70, 9.98] than during the week (9.45 SD= .90 [CI: 9.36, 9.53]).

As shown in Table 2, we found a significant correlation between mother-reported sleep and accelerometer-estimated sleep (r = .33, P < .001). A Bland-Altman plot for nighttime sleep duration is shown in Figure 1. This plot shows comparisons between mother-reported and accelerometer-estimated sleep duration by plotting differences in sleep duration maternal report and accelerometry. There was no significant bias detected in the regression analysis of the difference in sleep duration by maternal report and accelerometry on mean sleep duration. The mean difference between maternal report and accelerometer measures was not a function of the mean sleep duration.

We estimated bivariate correlations between sleep measures and child BMIz. Both mother-reported sleep and accelerometer-estimated sleep were significantly correlated with child BMIz ($r = -.18$, $P = .001$; $r = -.20$, $P = .001$, respectively). In addition, child pubertal status and maternal characteristics were also related to child BMI z-scores, including mothers' occupation ($r = -.16$, $P < .01$), Spanish-language acculturation ($r = .14$, $P = .02$), and BMI ($r = .32$, $P < .001$). Accordingly, these variables were used as covariates in subsequent multiple regression analyses. Child age and gender, mother's education and English-language acculturation were not correlated with child BMIz and therefore excluded from further analyses.

As shown in Table 3, we examined three multivariate linear regression models using one or both child sleep measures as explanatory measures in a model of child BMIz, with each model controlling for covariates. In the first model, longer sleep duration by maternal report was related to lower child BMIz ($\beta = -.13$, 95% CI: −.34, −.04; $P = .02$). In the second model, longer sleep duration based on accelerometry, was related to lower child BMIz ($\beta = -.17$; 95% CI: −.39, −.08; $P < .01$). In the third model, we included both mother-reported and accelerometer-estimated sleep durations. Only accelerometer-estimated sleep duration remained significantly related to lower child BMIz ($\beta = -.14$; 95% CI: −.36, −.03; $P = .02$).

In all three models, only two covariates were significantly related to child BMIz. More advanced pubertal stage was related to higher BMIz ($\beta = .17$; 95% CI: .24 – .25, 1.10 – 1.11; $P < .01$). In addition, higher maternal BMI was related to higher child BMIz ($\beta = .29$ to .31; 95% CI: .03, .06; $P < .001$).

As shown in Table 4, three multivariate logistic regression models using one or both variables for meeting the 10 hour sleep recommendation (based on maternal report and accelerometry) in a model of child overweight/obese status, with each model controlling for covariates. In the first model, children who did not meet the 10 hour sleep recommendation, based on maternal report, were at greater risk for being overweight/obese (OR: 2.1; 95% CI: 1.08, 4.24; $P = .03$) than those children who met the 10 hour recommendation. In the second model, we found no association between children who did not meet the 10 hour sleep recommendation, based on accelerometry, and risk for being overweight/obese. In the third model, we included both variables for meeting the 10 hour sleep recommendation and found no statistically significant association with being overweight/obese. The only significant covariate in all three models was maternal BMI, which was related to higher risk for being overweight/obese (OR =1.1; 95% CI: 1.03 – 1.04, 1.18 – 1.19; $P = .002 – .003$).

DISCUSSION

This study addresses a gap in the literature regarding the use of parent-reported sleep and objectively measured sleep to assess the sleep-obesity relationship in children. The first aim of the study was to examine the reliability of mother-reported with accelerometer-estimated sleep duration in Mexican American children. We found a correlation between mother-reported sleep and accelerometer-estimated sleep, and that mothers over-estimated sleep compared to accelerometer-estimated sleep duration. Secondly, we examined the relationships between mother-reported sleep duration, accelerometer-estimated sleep duration and obesity. We found that both measures were significantly related to child BMI z-score, independent of modeled covariates; however, only accelerometer-estimated sleep remained significant when both sleep measures were included in the same model. Lastly, we found that children who did not meet the 10 hour sleep recommendation were more likely to be overweight or obese than children who met the 10 hour sleep recommendation.

Our study examined the reliability of parent-reported sleep with accelerometer-estimated sleep. In this sample of mother-child pairs, mothers over-reported sleep by an average of 13 minutes. This small difference between sleep duration by maternal report and accelerometry and the moderate correlation between the two may lie in the inability of parents to account for sleep onset latency. Using accelerometry to assess sleep duration may be more reliable as accelerometers are able to detect small movements, such as restlessness or fidgeting that may occur right before a child falls asleep. Nevertheless, our findings suggest reasonable concordance and close agreement between the two sleep methods on the basis of the Bland-Altman plot, with no measurement bias detected (indicating that the measures agree equally).

Our findings show that a negative association between sleep duration and child BMI z-scores. Mexican American youth who slept fewer hours had higher BMI z-scores and this finding was consistent for both maternal report and accelerometer-estimated sleep, when they were considered separately. In these separate equations, each sleep measure remained significantly related to child weight status, even after accounting for multiple covariates. However, when both sleep measures were included in the same equation, only accelerometer-estimated sleep remained significantly related to BMI z-score. These findings suggest that maternal report of sleep alone may be sufficient for examining the cross-sectional relationship between children's usual sleep duration and adiposity. Similarly, we found that children who did not meet the 10 hour sleep recommendation had greater risk for being overweight or obese than children who obtained at least 10 hours of sleep. This association was consistently significant when examining each 10 hour sleep variable (based on maternal report and accelerometry) separately. Given these findings, accelerometer-estimated sleep may be a better measure of sleep duration for longitudinal purposes as it may provide a more reliable estimate of actual sleep time.. Because mothers tended to over-report sleep duration, nearly half of children met the sleep recommendation according to mothers' reports, compared with about a quarter of children who met the recommendation based on accelerometer data. Future research should consider the use of accelerometers to assess sleep when resources are available.

In our sample of Mexican American children, the average sleep duration was less than the 10 to 11 hour recommendation by the National Sleep Foundation to achieve adequate rest. Our findings echo others' report that Latino children are at risk for inadequate sleep duration, perhaps because they may have irregular and/or later bedtimes compared to other ethnic groups (Owens and Jones, 2011). Nevertheless, we found that children may attempt to obtain sufficient sleep on the weekend, in contrast to another study reporting that Hispanic youth were more likely to sleep less on the weekend (Adam et al., 2007). Lastly, our findings support previous research findings that Mexican American children who reported sleeping more than 9 hours per night had a lower BMI z-scores compared with those who slept less than nine hours per night (Silva et al., 2011). Future studies should investigate how to promote adequate sleep as a protective factor against childhood obesity. Also, efforts should be made to prevent the decreasing trend in sleep duration that occurs throughout childhood (Snell et al., 2007). Perhaps advocating for later school start times may help in this effort.

Child pubertal status and maternal BMI were significantly related to a higher child BMI z-score, as would be expected. Studies have noted that increased adiposity is associated with pubertal onset (Biro et al., 2006) and maternal BMI (Butte et al., 2007). Blair et al. reported gender differences in sleep and pediatric obesity (Blair et al., 2012). However, like Seo et al. (2010), we did not find any gender differences. Lastly, in the model examining mother-reported sleep, acculturation based on orientation toward Spanish language use was marginally related to a higher BMI z-score. Similarly, Wocjicki et al. (2012) found that speaking Spanish in the home was independently associated with risk for childhood obesity among Central and South Americans in the San Francisco Bay Area. Others have reported that Spanish-speaking Latino mothers may be more likely to push children to eat more and use positive incentives to get children to eat (Greenberg et al., 2007). This type of feeding behavior has been reported in several studies of Mexican mothers who culturally prefer a child that is *llenito* (diminutive of chubby) and do not recognize childhood overweight (Guendelman et al., 2010, Martinez et al., accepted).

The strengths of our study include the relatively large sample size. In addition, we measured sleep using two types of measurement – maternal report and accelerometry. Accelerometer-estimated sleep included three consecutive nights, including 2 weeknights and 1 weekend night. Another strength was the use of both measures to assess their respective utility in relation to children's weight. Future investigators aiming to assess sleep duration longitudinally should consider using accelerometers when sufficient resources are available. Another strength of the current study was the focus on Mexican American children, a group with some of the highest obesity rates but about whom little is known regarding sleep as a risk factor for obesity. Although our findings may not be generalizable to other Latino subgroups or other ethnic groups, we were able to provide support for the relationship between insufficient sleep duration and obesity in Mexican American children. These findings can begin to inform pediatric obesity prevention in this at-risk population. Future studies could also examine these relationships in younger children as well as other Latino subgroups and other ethnic groups.

A limitation of the current study includes the narrow age range of child participants, who were 8 to 10 years old. Our findings should not be generalized beyond this age range. This study was cross-sectional; therefore, causality could not be determined. Lastly, this study used three days of accelerometer-estimated sleep duration compared to at least 5 days of monitoring. Despite this limitation, three days of sleep monitoring was a more reliable estimate compared with mother-reported.

While mothers over-reported children's sleep in this sample, mother-reported sleep was in agreement with accelerometer-estimated sleep. Both measures of sleep duration were negatively related to BMI status, suggesting that children who slept less had a higher risk for greater adiposity. Our results contribute to the growing body of evidence suggesting that insufficient sleep exacerbates the growing epidemic of childhood obesity. Lastly, our findings suggest that parent-reported sleep may provide a reasonable estimate to examine sleep and adiposity in cross-sectional studies.

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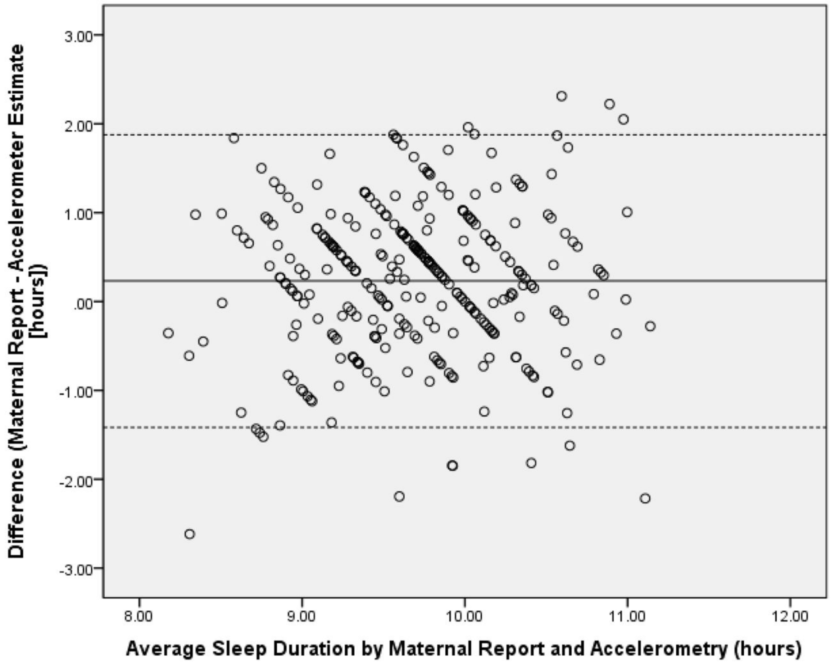

Figure 1.

Bland-Altman plot between maternal reported and accelerometer-estimated sleep duration (n = 303). The broken horizontal lines represent the limits of agreement. The solid horizontal line represents the mean difference.

Table 1

Descriptive characteristics of Mexican American mother-child pairs (N=303)

Variable (range)	**% or Mean (SD)**
Child	
Female	54%
Age (8–10 years)	8.86 (.82)
Pubertal status (1–5)	1.32 (.26)
BMI z-score	.97 (1.02)
Overweight	20%
Obese	30%
Meets the NSF sleep recommendation[a]	
≥ 10 hour sleep duration (accelerometer)	26%
≥ 10 hour sleep duration (maternal report)	52%
Mother	
Education (0–19 years)	10.79 (3.67)
Occupational status (1–9)	3.27 (2.10)
Acculturation (1–5)	
English language	2.64 (1.28)
Spanish language	4.21 (1.12)
BMI	30.38 (6.86)
Overweight	33%
Obese	48%

[a]National Sleep Foundation recommendation for 5- to 12-year-olds

Table 2

Nighttime sleep duration and correlation between sleep measures in Mexican American 8- to 10-year-olds

Sleep Measure	Mean (SD)	Median	Pearson Correlation	Mean difference (95% CI)
Maternal report (hrs)[a]	9.81 (.74)	10.00	.33	0.23 ± 0.84 (0.14, 0.33)
Accelerometry (hrs)	9.58 (.71)	9.55	(P < .001)	
Week night[b]	9.45 (.90)	9.42		
Weekend night	9.84 (1.25)	9.85		

[a]Mother-reported and accelerometer-estimated sleep were statistically different (P < .001).

[b]Week night and weekday sleep duration were statistically different (P < .001).

Table 3

Multivariate linear regressions with child sleep measures and child BMI z-score, showing standardized β coefficients (95% CI).

	Child BMI z-score		
Independent variables	**Model 1**	**Model 2**	**Model 3**
Mother-reported sleep	−.13 (−.35, −.04)*	--	−.09 (−.29, .03)
Accelerometer-estimated sleep	--	−.17 (−.39, −.08)*	−.14 (−.36, −.03)*
Covariates			
Child pubertal status	.17 (.24, 1.10)**	.17 (.25, 1.11)**	.17 (.24, 1.0)**
Mother BMI	.31 (.03, .06)**	.30 (.03, .06)**	.29 (.03, .06)**
Occupational status	−.08 (−.10, .03)	−.09 (−.11, .02)	−.09 (−.11, .02)
Mother Spanish Acculturation	.11 (−.02, .21)	.11 (−.02, .21)	.11 (−.02, .21)
R^2	**.18**	**.20**	**.20**

*P < .05;

**P ≤ .001

Table 4

Multivariate logistic regressions examining the 10 hour NSF sleep recommendation and child overweight/obesity, showing Odds Ratios (95% CI).

	Child overweight/obese weight status		
Independent variables	**Model 1**	**Model 2**	**Model 3**
< 10 hour sleep duration (maternal report)	2.1 (1.08, 4.24)*	--	1.9 (0.94, 4.00)
< 10 hours sleep (accelerometer)	--	1.8 (.83, 5.1)	1.4 (0.61, 3.52)
Covariates			
Child pubertal status	3.6 (.86, 15.04)	3.1 (.76, 3.6)	3.5 (.84, 14.8)
Mother BMI	1.1 (1.04, 1.19)*	1.1 (1.03, 1.18)*	1.1 (1.03, 1.18)*
Occupational status	1.1 (.89, 1.34)	1.1 (.87, 1.29)	1.1 (.88, 1.33)
Mother Spanish Acculturation	1.1 (.79, 1.53)	1.1 (.81, 1.54)	1.1 (.79, 1.52)
R^2	**.17**	**.15**	**.18**

*P < 0.05; Reference group (1): ≥ 10 hour sleep duration