Early childhood sleep duration predicts adiposity and changes in childhood body mass index

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Background

- A growing body of research has linked insufficient sleep during infancy with higher body mass index (BMI) and odds of overweight/obesity in preschool.
- This research is limited by the use of single follow-up measures of height/weight (and derived BMI) to infer obesity. While BMI is commonly used, it is an indirect measure of body fat.
- Research that examines the impact of early childhood sleep on school-age outcomes and incorporates serial measures of height/weight and non-BMI measures of adiposity is needed to enhance our understanding about the persistence and robustness of the potential effect of early sleep on later obesity risk.
- The current secondary analysis of data collected in a pre-birth cohort examined early childhood sleep duration as a predictor of mid-childhood BMI z-score trajectory and percent body fat.

Methods

- Health Outcomes and Measures of the Environment Study: Pre-pregnancy birth cohort designed to examine health effects of common environmental toxicant exposures. The 398 women enrolled delivered 389 singletons and 9 sets of twins. Only singletons were included in these analyses. 94 families were completely missing data for sleep and/or anthropometry to result in a final sample size of 295.
- Home and clinic visits or phone interviews were conducted during pregnancy, within 48-h of delivery, and throughout infancy (ages 1, 6, 12, 18, and 24 months) and childhood (ages 3, 4, 5, and 8 years).

Measures

- Sleep Behaviors: Administered by trained research staff during clinic visits or by phone at ages 6, 12, 18, and 24 months. Mothers reported total sleep duration combining daytime naps and nighttime sleep. Mothers also reported whether the child shared a bed with another family member or slept independently at each age.
- Anthropometrics: Weight and height were obtained at ages 3, 4, 5, and 8 years by trained research personnel. BMI z-scores were derived using the 2000 CDC growth charts. 81% of children provided anthropometry for at least 2 time points (mean observations per child= 2.9). Percent body fat was measured using a portable bioelectrical impedance monitor at age 8 (Tanita, Arlington Heights, IL).
- Potential Confounding Variables: Maternal age, pre-pregnancy BMI, marital status, income, parity, quality of the caregiving environment, child sex, child race/ethnicity, birth weight, gestational age, breastfeeding duration, and child sleep arrangement.

Statistical Analytic Plan

- Descriptive statistics including means and standard deviations were first calculated.
- Two unconditional latent growth curve models were used to examine the shape and optimal form of change in early childhood sleep duration (across ages 6 to 24 months) and BMI z-score (across ages 3 to 8 years). No change/intercept-only, linear, quadratic, and cubic models were considered. Latent variables were used to describe average response variable trajectories and model inter-individual variations in trajectory components. Fit indices and parameter estimate significance tests were used to determine the best fitting models.
- Intercept-only provided the best fit to the data for total sleep duration. This reflected the relatively stable, average sleep duration observed across the 6 to 24-month-old period. A linear model was the best fit for BMI z-score trajectory. BMI z-score was significantly different from zero at age 3 and increased through age 8.
- Early childhood sleep duration was regressed onto (a) BMI z-score growth trajectory across ages 3 to 8 years and (b) percent body fat at age 8. Models controlled for the potential confounding influences listed in the Methods section. All models were tested in Mplus Version 8.1.

Results

- Children slept a mean (SD) of 12.6 (2.2), 12.6 (1.8), 12.4 (1.6), and 12.5 (1.5)-h at 6, 12, 18, and 24 months, respectively. These means fall within the recommended range of 11 to 14-h for 1-2-year-olds but are at the lower end of the 12 to 15 or 16-h range for 6-12-month-olds. 21-29% were considered short sleepers (<12-h) at 6 and 12 months, and 10-12% (<11-h) at 18 and 24 months.
- BMI z-score increased over time. 18-19% were considered overweight or obese (BMI ≥ 85th percentile) at 3, 4, and 5-years, and 26% at age 8. Eight-year-olds with overweight or obesity had significantly higher body fat percentages than children considered healthy weight (M=29.1, SD=6.5 vs M=18.2, SD=3.6).
- Early childhood sleep duration did not predict BMI z-score intercept but did predict BMI z-score slope (β=-.04 [95% CI: -0.05 to -0.02]). Early childhood sleep duration predicted percent body fat at age 8 (β=-1.90 [95% CI: -2.72 to -1.09]).
- For every 1-h decrease in early childhood sleep duration, BMI z-score increased by approximately .04 BMI z-score units each year and body fat increased by almost 2% at age 8. Figures 1 and 2 succinctly illustrate the statistical link between sleep and BMI z-score or body fat by comparing children who obtained <12-h or ≥ 12-h at age 6 months.

Results

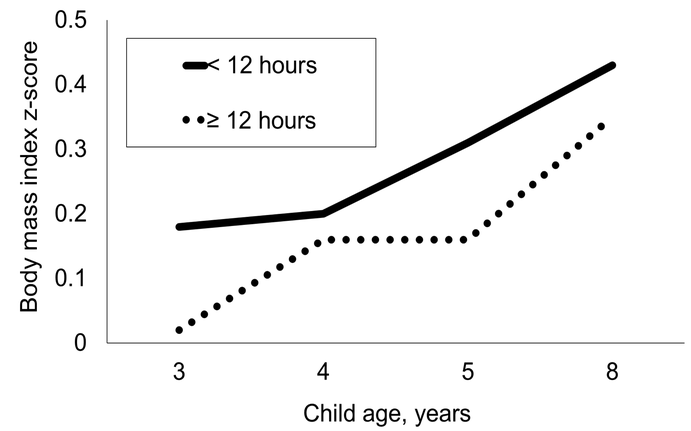

Figure 1. Body mass index z-score trajectory from ages 3 to 8 years based on whether the child obtained 12-h or fewer of sleep per 24-h period at age 6 months.

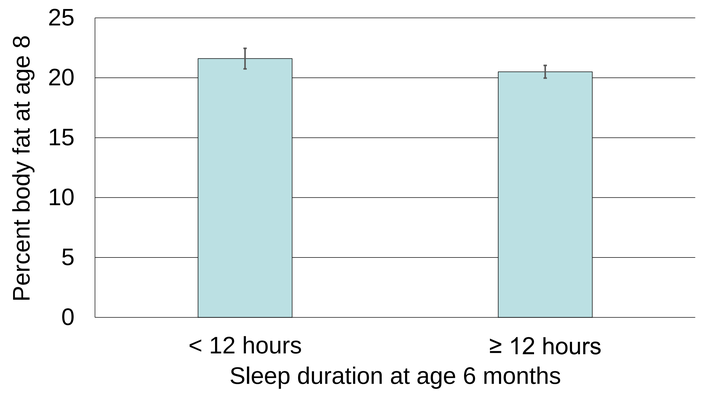

Figure 2. Percent body fat at age 8 based on whether the child obtained 12-h or fewer of sleep per 24-h period at age 6 months.

Conclusions

- In the current study, shorter sleep duration in early childhood was associated with greater increases in BMI z-score trajectory and higher percent body fat. Insufficient sleep in early life may set children on a trajectory towards accelerated weight gain and greater accrual of body fat.
- Replication of these associations using objective sleep measurement tools and identification of plausible mechanisms is needed before engaging in the design and evaluation of behavioral sleep prevention programs to promote healthy weight outcomes.