



Infant sleep problems and childhood overweight: Effects of three definitions of sleep problems

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ABSTRACT

Sleep problems have been defined using a variety of definitions. No study has assessed the longitudinal association between infant sleep problems and childhood overweight or obesity using existing definitions of sleep problems. This study used longitudinal data ($n = 895$) from the multi-site Study of Early Child Care and Youth Development (SECCYD) to investigate the effects of infant sleep problems on childhood weight status in Grade 6. Infants with sleep problems in Phase I (1991) and with complete data through Phase III (2004) of SECCYD were included. Sleep problems were assessed using maternal reports of night wakings and duration of a waking episode. Sleep problems were defined using Richman (1981), Lozoff et al. (1985), and Zuckerman et al. (1987) definitions. Multinomial logistic regression was used to examine the association between sleep problems during infancy and childhood weight status in Grade 6 while controlling for birth weight, race, sex, breastfeeding, maternal poverty, family structure, and maternal education. After adjusting for all covariates, children with a history of sleep problems were found to be overweight in Grade 6 using Zuckerman et al. (Odds ratio (OR) = 1.68; 95% confidence interval (CI): 1.11–2.55) and Richman (OR = 1.76; 95% CI: 1.05–2.97) definitions, but not using Lozoff et al. definition. Infant sleep problems were not found to be associated with being obese. The study found differential effects of infant sleep problems on childhood overweight in Grade 6 per different definitions of sleep problems. Findings highlight the need to construct a single definition of infant sleep problems.

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1. Introduction

The unhealthy accumulation of adiposity has become a major public health issue in the United States for all ages. During the past 30 years, the prevalence of obesity has doubled among children and quadrupled among adolescent population (Centers for Disease Control and Prevention, 2016). According to the latest National Health and Nutrition Examination Survey data, 8.1% of infants and toddlers had high weight for recumbent length, and 16.9% of 2 to 19 year-olds were obese in 2011–2012 (Ogden et al., 2014). Elevated levels of body mass index (BMI) place children and adolescents at an increased risk for heart disease, type 2 diabetes, stroke, osteoarthritis, multiple cancers, and adult obesity (Centers for Disease Control and Prevention, 2016; Daniels et al., 2005).

Sleep problems, such as frequent night waking and settling problems affect 20% to 30% of children one to five years of age. Among these children, 40% to 80% will continue to have sleep difficulties for an additional two to three years (Bruni & Novelli, 2010). Sleep problems are associated with a variety of comorbid conditions including obesity, metabolic syndrome, growth hormone deficiency, allergic conditions, neoplasms, and blood malignancies (Lazaratou et al., 2012). Despite the high prevalence and adverse health outcomes associated with sleep problems, assessment of the latter by medical professionals is often overlooked during routine care (Smaldone et al., 2007).

The deleterious and costly effects of an imminent overweight and obese generation have prompted immediate attention from various societal institutions. Several cross-sectional studies have shown an association between sleep problems and overweight and obesity in childhood and adolescence by primarily focusing on sleep duration as the measure of interest (Shi et al., 2010; Lumeng et al., 2007; Chaput et al., 2006; Padez et al., 2005), but only a few have examined beyond this component. A recent cross-sectional study examined the relation between a set of defined sleep dimensions (duration, disturbances, and patterns) and childhood and adolescent obesity (Jarrin et al., 2013). Results of this study revealed that sleep difficulties were reported by subjects with high BMI (Jarrin et al., 2013). Wake times and bed times have

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also been observed to be predictive of youth BMI measures (Olds et al., 2011). A few mechanisms have been proposed to explain the association between sleep restriction and overweight. Several studies have found a link between sleep duration and changes in the levels of hormones including cortisol, leptin and ghrelin (Spiegel et al., 2004; Schmid et al., 2008; Omisade et al., 2010). These changes lead to decreased energy expenditure and increased energy intake. Shorter sleep duration has been also associated with less physical activity (Taheri et al., 2004) and increased consumption of high-calorie foods (Fleig & Randler, 2009).

The association between infant sleep problems and weight status in children has received less attention (Taveras et al., 2008), perhaps because of the existence of varying definitions of sleep problems in the literature (Richman, 1981; Lozoff et al., 1985; Zuckerman et al., 1987; Wolke et al., 1995; Gaylor et al., 2001). For instance Richman (1981), defined sleep problems as waking 5 or more nights per week in addition to one of the following: co-sleeping with parents, waking 3 or more times per night, or waking event lasting at least 20 min. Lozoff et al. (1985) defined sleep problems as night waking occurring 3 or more times per week accompanied by parental report of disturbance. Zuckerman et al. (1987) defined sleep problems as waking 3 or more times per night, waking event lasting at least 1 h, or parental report of “severe” disturbance.

A few other investigators have attempted to provide a more contemporary definition of sleep problems in the hope to provide a more specific guide for classification. Wolke et al. (1995) assessed sleep problems among preterm and full term infants. For the age of 5 months, problems were indicated if night waking occurred 5 or more times per week at least one time per night (severity classification: slight), at least 2 times per night (severity classification: severe), arousal lasting 15 to 29 min (severity classification: moderate), arousal lasting 30 min or longer (severity classification: long), and report of parental distress. For the age of 20 months, problems were indicated if night waking occurred 5 or more times per week at least one time per night. Lastly Gaylor et al. (2001), constructed a definition of sleep problems using the Diagnostic and Statistical Manual of Mental Disorders, 4th edition; infant sleep problems were defined as waking >2 nights per week, difficulty falling asleep lasting >30 min for 1 to 2 year-olds, difficulty falling asleep lasting >20 min for children aged 2 years and older, and by degree of severity.

To our knowledge, no study has examined the long-term effects of infant sleep problems, as defined by existing definitions of sleep problems, on childhood overweight or obesity. In a multi-site longitudinal study conducted by the National Institute of Child Health and Human Development (NICHD), sleep problems were assessed using Richman (1981), Lozoff et al. (1985), and Zuckerman et al. (1987) definitions along with an intra-study constructed definition. This study aimed to investigate the relation between sleep problems in infancy, as defined by Richman (1981), Lozoff et al. (1985), and Zuckerman et al. (1987), and the risk of childhood overweight and obesity.

2. Methods

2.1. Participants

Prospective data from Phase I (1991) and Phase III (2004) of the Study of Early Child Care and Youth Development (SECCYD) of the NICHD were used. SECCYD was a longitudinal study that followed a cohort of children from birth through 9th Grade. Participants were recruited in 1991 from 24 designated hospitals at 10 data collection sites across the United States. Participant recruitment and selection procedures are described in detail elsewhere (National Institute of Child Health and Human Development Early Child Care Research Network, 2001). In brief, of the initial pool of 3015 eligible mothers with healthy newborns contacted at two weeks for participation, 1364 (45%) completed the 1-month home interview and became study participants. Eligibility

requirements specified that mothers be 18 years or older, English-speaking, and have no known or acknowledged history of substance abuse; and that infants not be hospitalized at birth for >7 days nor have any obvious disabilities. This resulted in screening out very low birth weight, premature, or sick infants. A study conducted by the NICHD compared characteristics of subjects who agreed to participate in SECCYD and those who refused to participate (National Institute of Child Health and Human Development Early Child Care Research Network, 2001). The results showed a few small differences. Mothers who agreed to participate were slightly better educated (65% with more than a high school degree vs 50%) and less likely to be minority (19% vs 24%). Children who participated were a little heavier at birth (3.49 kg vs 3.39 kg). At Phase III, 1061 subjects remained in the study. The follow-up attrition rate was 22.2%.

At 6th Grade (i.e., Phase III of SECCYD), 895 children had complete anthropometric data. Much of the missing anthropometric data were due to families' moving to other communities. Children with missing sleep problems' data in infancy or anthropometric measures at 6th Grade were excluded from the analysis, which resulted in a final sample size of 895 children (65.6% of the original cohort). This study was approved by the institutional review boards of all the participating institutions.

2.2. Data collection

2.2.1. Measurement of sleep problems

Data regarding sleep problems were obtained by maternal reports of infant behaviors at 6 months and 15 months of age. Three sleep measures were used to assess infant sleep problems. *Night wakings in the last week* was assessed by asking the mothers to respond “yes” or “no” to the following question: “In the last week, has baby wakened you at night?” If the mothers answered “yes” to the previous question, they were then asked to record the frequency of waking events per week and the frequency of waking events per night; the response choices ranged from 1 to 7 for both questions. *Average length of night waking* was assessed by recording the number of minutes in response to the following question: “On average, for about how long would you say baby was up each time baby awakened?” *Maternal report of sleep disturbances* was based on the maternal response to the question, “How much of a problem has baby's awakening been for you? Response choices included: “Not much”, “Somewhat”, and “Quite a bit” (United States Department of Health and Human Services, National Institutes of Health, Eunice Kennedy Shriver National Institute of Child Health and Human Development, 1991–1995). Sleep problems were operationalized within SECCYD using Richman (1981), Lozoff et al. (1985), and Zuckerman et al. (1987) definitions of sleep problems as defined above. Lozoff et al.'s definition was validated by applying discriminant analysis prediction to data from a second sample of children in their study (Lozoff et al., 1985). The intercorrelations between all three sleep measures were tested within SECCYD and results showed that all three definitions were significantly different from each other, indicating that each measure reflects different aspects of sleep problems (National Institute of Child and Human Development Study of Early Child Care and Youth Development, 1995) Infants with sleep problems at 6 months and/or 15 months were included in the analysis.

2.2.2. Measurement of BMI

Height and weight were measured during laboratory visits in Grade 6 by trained research assistants using standardized procedures. BMI was calculated by dividing weight (kg) by height (m) squared. BMI was defined as normal: BMI 5th–<85th percentile; being overweight: BMI 85th–<95th percentile; or being obese: BMI ≥ 95th percentile according to the 2000 Centers for Disease Control and Prevention's sex-specific cut-offs for age-group (Barlow & Expert, 2007).

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