



Associations between physical and sedentary activity regularity and sleep in preschoolers and kindergartners



Kara M. Duraccio, MS*, Chad D. Jensen, PhD

Brigham Young University

ARTICLE INFO

Article history:

Received 11 January 2017

Received in revised form 13 March 2017

Accepted 3 April 2017

Keywords:

Sleep

Physical activity

Sedentary activity

Children

ABSTRACT

Short sleep duration in childhood has been associated with increased risk for overweight and obesity. Research suggests that physical activity might mediate this association. However, studies examining associations between physical activity and sleep in young children have reported equivocal findings. A possible explanation for these inconsistencies is that past studies have looked at total physical activity rather than examining physical activity regularity. We aimed to explore the associations between physical and sedentary activity regularity (ie, consistent vs intermittent behavior) and sleep in preschoolers and kindergartners. One hundred and thirty-one children (ages 4–6) wore waist-worn accelerometers for 3 days and 3 nights. Associations between physical and sedentary activity regularity and attaining adequate sleep duration were assessed using logistic regression. There was no association between the number of days that children engaged in ≥ 60 minutes of total physical activity and sufficient sleep. Furthermore, there was no association between the number of days that children engaged in ≥ 20 minutes of vigorous activity and sufficient sleep. Children who engaged in minimal sedentary activity had greater odds of obtaining sufficient sleep as compared with children who engaged in more sedentary activity.

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The National Sleep Foundation recommends that preschoolers and kindergartners obtain 10–13 hours of sleep per night.¹ Children who fail to meet these sleep requirements have been shown to experience deficits in decision making and attention, and poorer overall well-being.² Furthermore, inadequate sleep in children has been shown to be associated with a reduction of growth hormones and a dysregulation of appetite hormones,³ as well as an increase in total caloric consumption.⁴ Achieving adequate sleep duration is important for the normal functioning of metabolic and hormonal processes in children. Short sleep duration has also been shown to be associated with overweight and obesity in children.^{5–9} Several longitudinal studies have been conducted to determine the causal impact of sleep duration on future body mass index (BMI). Two-year-old children who obtained fewer than 11 hours of sleep per night were more likely to be obese at age 7 than children who slept more than 12 hours per night.¹⁰ Additionally, children who were overweight at age 9 were reported to sleep an average of 30 fewer minutes per night at ages 3–5 compared with their normal-weight

peers.¹⁰ Bell and Zimmerman¹¹ found that sleep duration was associated with obesity risk 5 years later for children ages 0–4 but not for children ages 5–13. Examining the sleep habits of young children may provide better predictions of future weight status than examining sleep habits in older children.

The relationship between sleep and childhood obesity may be partially mediated by physical activity. The Centers for Disease Control and Prevention suggest that children engage in at least 60 minutes of physical activity daily.¹² Studies show that adolescents who engage in more physical activity have higher odds of obtaining sufficient sleep than those who engage in less physical activity,^{13,14} although some investigators have found this only to be true for higher-intensity physical activity.¹⁵ However, there is a lack of consensus regarding the effects of physical activity on sleep in younger children. Higher levels of physical activity in young children have been associated with decreases in sleep duration and quality.^{16,17} Other sources have found no relationship between sleep duration and physical activity in young children.¹⁸ Additionally, some researchers have found that physical activity duration does not directly mediate the relationship between sleep duration and BMI in young children.^{19,20} As the literature has reported equivocal findings regarding the association between physical activity and sleep duration in younger children, this question merits additional research.

* Correspondence to Kara M. Duraccio, MS, Department of Psychology, Brigham Young University, 223 TLRB, Provo, UT, 84602.

E-mail address: kara.duraccio@gmail.com (K.M. Duraccio).

One potential explanation for these equivocal findings is that total amount of physical activity may not be as influential on sleep duration as regularity of physical activity (ie, consistent daily activity). Several studies within the adolescent literature have shown that regularity of physical activity, rather than intensity or total time of physical activity, was associated with improved sleep patterns in adolescents.^{21–23} More recently, Foti and colleagues¹³ demonstrated that adolescents who engaged in at least 60 minutes of physical activity on 4 or more days during the week had higher odds of obtaining sufficient sleep (ie, 8 or more hours of sleep) than adolescents who did not engage in 60 minutes of physical activity on any given day. Additionally, odds of obtaining sufficient sleep were higher for adolescents who engaged in more than 20 minutes of vigorous activity on 5 or more measurement days. These findings suggest that the effect of physical activity on sleep duration may be additive, such that regular participation in physical activity is more likely to positively impact sleep duration, whereas a single bout of physical activity would be less likely to have salutary effects on sleep duration. To date, no study has examined the relationship between physical activity regularity and sleep in young children.

Furthermore, sedentary behaviors such as television watching and computer use have been shown to be negatively associated with children's sleep duration,^{15,24} although the evidence for this relationship is equivocal.²⁵ Foti and colleagues¹³ also examined the impact of sedentary behaviors on the odds of obtaining sufficient sleep. Interestingly, they found that adolescents who watched 4 or more hours of television daily were more likely to obtain sufficient sleep as compared with adolescents who watched less television. However, they found that adolescents who used the computer more frequently were less likely to obtain sufficient sleep. Because of these contradictory findings, further research is needed to examine the relationship between sedentary behaviors and sleep duration, especially within younger children.

Although regular physical activity has been shown to be associated with improved sleep in adolescents, these findings have not been extended to young children, particularly preschoolers/kindergartners. This is a critical age to study sleep habits, as sleep habits at this age have been shown to predict later BMI.¹¹ Furthermore, previous research examining physical activity regularity has relied upon self-report measures for determining physical activity duration and intensity. No previous studies have used objective measures to assess regularity of physical activity. We suspect that this reliance on self-report measures of physical activity paired with only examining total minutes of physical activity (rather than examining regularity of physical activity) has contributed to the inconsistency in the literature regarding the relationship between physical activity and sleep. Therefore, we hypothesize that greater regularity of total physical activity (measured objectively) among preschoolers and kindergartners will be associated with increased likelihood of obtaining sufficient sleep. Furthermore, given that previous literature has established the unique influence of vigorous physical activity on sleep, we hypothesize that greater regularity of vigorous physical activity will be associated with increased likelihood of obtaining sufficient sleep. Finally, we hypothesize that greater regularity of sedentary behavior will be associated with decreased odds of obtaining sufficient sleep.

Methods

Participants

Participants (N = 131) included parent/child dyads recruited from a university-based preschool/kindergarten program during the 2012–2013 and 2013–2014 school years. Our study sample consisted of children ages 4 to 6 (M = 4.91, SD = 0.48; 43.5% female).

Seventy-four percent of our sample was white (see Table 1 for demographic information). All children attending the school were invited to participate in the study through an e-mail sent to their parents by the school study staff. Informed consent was gathered from all parents/guardians prior to study enrollment. Parents received a \$10 gift card upon the completion of the study.

Procedures

All study procedures were approved by the university preschool/kindergarten and the authors' institutional review board. Parents provided informed consent and demographic data about their children electronically via an online survey. Child height was measured with a portable stadiometer (SECA 215), and weight was measured with an electronic scale (SECA 813). Data were collected as part of a larger study evaluating fruit/vegetable consumption and physical activity trends in preschoolers/kindergartners. As such, accelerometer-measured sleep and physical activity outcome data were collected during a 3-day measurement period using waist-worn accelerometers (Actigraph GT3X+). The reliability estimates for assessing sleep duration over 3 nights in a 5-year-old population is estimated at 0.76.²⁶ Furthermore, reliability estimates for assessing regularity of physical activity across a 4-day sampling period ranged from 0.64 to 0.77. Trained research assistants allowed the participants to handle the accelerometers before receiving verbal assent and placing them on the right hip of all participating children. Accelerometers were placed Monday mornings and were collected Thursday mornings. Children wore the accelerometer for 72 consecutive hours and were asked to only remove the accelerometer for swimming and bathing. Instructions for wear were given to the parents to maximize wear time. Data collection occurred in September and October of 2012 and 2013 to reduce seasonal confounds. Preschool duration was 2.5 hours per day, whereas kindergarten duration was 2.75 hours.

Measures

Basic demographic information was gathered from all participants, including date of birth, sex, and ethnicity. After gathering weight and height estimates, body mass index percentile for age and sex (BMI%) was calculated for each participant. BMI% is a moderately reliable indicator of body fat percentage²⁷ and has a moderate inverse relationship with measures of cardiovascular fitness, such that individuals with a higher BMI% are less likely to be

Table 1
Demographic information.

Variables	n	%
Age (y)		
4	70	53.4
5	49	37.4
6	3	2.3
Missing	9	6.9
Sex		
Male	65	49.6
Female	57	43.5
Missing	9	6.9
Race/ethnicity		
White	97	74.0
African American	0	0.0
Hispanic	2	1.5
Native American	1	0.8
Asian	2	1.5
Other	5	3.8
Missing	24	18.3
	M	SD
Yearly income	67,328.20	40,954.89
Parent age	35.20	4.99

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