Preventive Medicine Reports 12 (2018) 54–59

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Sleep matters: The association of race, bedtime, outdoor time, and physical activity with preschoolers' sleep

Allison A. Parsons[a,*], Nicholas J. Ollberding[b,d], Laurie Smith[b], Kristen A. Copeland[c,d]

[a] Division of Critical Care, Cincinnati Children's Hospital Medical Center (CCHMC), 3333 Burnet Ave, Cincinnati, OH 45229, United States of America
[b] Division of Biostatistics and Epidemiology, CCHMC, 3333 Burnet Ave, Cincinnati, OH 45229, United States of America
[c] Division of General and Community Pediatrics, CCHMC, 3333 Burnet Ave, Cincinnati, OH 45229, United States of America
[d] Department of Pediatrics, University of Cincinnati College of Medicine, 3230 Eden Ave, Cincinnati, OH 45267, United States of America

ARTICLE INFO

Keywords:
Sleep
Childcare
Race
Physical activity
Preschool aged children

ABSTRACT

Sleep is necessary for optimal functioning. Little is known about the extent to which race and opportunities to be active influence sleep in preschool-aged children attending full-day child care. Participants (n = 359) in this cross-sectional study attended 30 randomly selected, childcare centers in Cincinnati, OH. Data collection occurred from November 2009 to January 2011. Hierarchical linear regression and generalized estimating equations tested for associations between nighttime sleep duration and race, outdoor/indoor active time, actual physical activity (PA), screen time, daytime nap, and bedtime after 9 pm. Participants slept a mean ± SD of 1.5 ± 0.8 h at childcare and 9.7 ± 1.0 h at bedtime. White children (β = 0.57 ± 0.14, p < 0.01) and children identifying as Other race (β = 0.40 ± 0.15, p < 0.01) slept more hours than Black children at nighttime. White children were less likely to nap at childcare than Black children. Inside PA time provided was associated with increased nighttime sleep duration (β = 0.092 ± 0.04 h per 30 min PA, p < 0.03). There was no association between outdoor time or moderate to vigorous PA and nighttime sleep. Black children slept less at night on average, but were more likely to engage in nap sleep at childcare resulting in similar overall sleep duration. Additional studies in diverse populations that explore the effects of nighttime versus nap time sleep on child health and well-being are needed.

1. Introduction

The appropriate amount of sleep is necessary for physical and mental functioning across all ages. Sleep is particularly important for young children as the hormones necessary for growth and development are released during sleep states (Paruthi et al., 2016). Nighttime sleep is known to be positively associated with biological, psychosocial, and overall wellbeing functions (Taheri, 2006; Ward et al., 2008; Weissbluth, 2015). Insufficient total sleep duration has been associated with adiposity in early childhood (Taheri, 2006; Sekine et al., 2002; Taveras et al., 2008; Padez et al., 2005). The mechanisms that drive the relationship between sleep and overweight/obesity in young children are not fully understood (Bell and Zimmerman, 2010).

The American Academy of Pediatrics supports the American Academy of Sleep Medicine guidelines that indicate preschool aged children (i.e. 3 to 5 year olds) should obtain 10 to 13 h of sleep per 24 h, including naptime sleep (Paruthi et al., 2016). In a secondary analysis of nationally representative sample, investigators found that children between the ages of 3 and 5 years old did in fact get 11 to 13 h of sleep over a 24 h period (Williams et al., 2013). Several factors have been linked to nighttime sleep duration, including bedtime, napping, daytime physical activity, and outdoor time. Later bedtimes have been associated with reduced sleep duration in children younger than two years of age (McDonald et al., 2014). The association between napping and nighttime sleep is unclear. In previous studies, Black children were more likely to nap and have shorter sleep duration than White children (Crosby et al., 2005; Lavigne et al., 1999). In these studies, however, children were not recruited from, and behaviors were not observed within, a child care setting. The majority (61%) of preschool-aged children spend time in child-care settings outside the home (Child FIFo, Statistics F, 2005). Little is known about how child-care settings may promote or hinder children's sleep (Ward et al., 2007). Because napping is an integral part of child care routines, this question warrants further study in preschoolers within a child care setting.

The relationship between sleep and physical activity (PA) among school-aged children has been examined previously; although, results

* Corresponding author at: Division of Critical Care, CCHMC, 3333 Burnet Ave, Cincinnati, OH, United States of America.
E-mail address: Allison.parsons@cchmc.org (A.A. Parsons).

https://doi.org/10.1016/j.pmedr.2018.08.008
Received 31 January 2018; Received in revised form 16 August 2018; Accepted 21 August 2018
Available online 29 August 2018

have been inconsistent (Hager et al., 2016). Though one study of toddlers found that shorter sleep duration was associated with decreased PA, this study did not consider the effects of napping (Hager et al., 2016). The association between sleep and screen exposure has received the greatest attention with the presence of a TV in the bedroom, the number of hours participating in screen time, and participating in screen time at or near bedtime reported to negatively impact sleep (Hill et al., 2016; Owens et al., 1999).

The purpose of this study was to examine the relationship between nighttime sleep duration and race, outdoor and indoor active time, actual PA, daytime nap, bedtime after 9 pm, and screen time in preschoolers aged 3 to 5 years attending full-day child care.

2. Methods

2.1. Study design

The data used for this analysis were collected from November 2009 to January 2011 as part of the Preschool Eating and Activity Study (PEAS), a cross-sectional study of the influence of the child care center environment on children's 24-hour physical activity (PA) (Copeland et al., 2016). The analytic sample consisted of n = 359 children in two randomly selected preschool classrooms in 30 randomly selected child-care centers (n = 60 classrooms) in Ohio. Centers were eligible if they offered full-day care to preschool-aged children. All children who were 36–72 months, enrolled in one of the randomly selected classrooms for at least one month, were present on the day of observation, did not have a disability prohibiting PA, and provided data on nighttime sleep and key covariates were eligible. All data was collected on either a Tuesday or a Wednesday to avoid sleep schedule shifts that can occur during the weekend. Ethical approval to conduct the research was obtained from the Institutional Review Board of Cincinnati Children's Hospital Medical Center.

2.2. Measures

2.2.1. Outcome variables

2.2.1.1. Sleep. The outcome measure nighttime sleep was defined as the time spent asleep at night. Sleep at night was primarily assessed using a one day sleep diary, in which parents reported their child's bedtime on the day of observation and rise time on the following day. The sleep diaries were also used to determine if the child went to bed before or after 9 pm. A 9 pm bedtime cutoff was used as prior research has shown that this is, in general, when the majority of children this age go to bed in the U.S. (Anderson et al., 2016). Sleep times for sleep duration were estimated within 15 min.

As a back-up if the sleep diary was not returned or if there was missing data in the diary or if there was a question regarding the accuracy of the sleep and wake times recorded in the diary (< 3% of sample), manual checking of accelerometry output was used to estimate bedtime and/or rise time (Lam et al., 2011). Study staff observed nap at the center and recorded the beginning and end of the time period allotted for nap, as well as individual times participating children fell asleep and woke from nap. Study staff were to scan the room every 5 min to check for any new children who had fallen asleep or awaken. The sleep times for nap observation data were estimated within 5 min. Total sleep included the time spent asleep at night and at nap.

2.2.2. Exposure variables

2.2.2.1. Physical activity. Actual time allotted to children to spend outdoors and in the gym on the day of observation was recorded by study staff. Actical uniaxial accelerometers (Mini-Mitter®, USA) (15-s epoch) were used to objectively measure PA for 24 h. The Acticals were attached to belts and placed on the child's right hip by study staff upon arrival at the center on the observation day, and removed the following morning. Established cut offs for count per minute (Pfeiffer et al., 2006) were used to quantify time (minutes/hour) spent in moderate, vigorous, light, and sedentary activity. Sleep at night, time allotted for nap, and non-wear times were removed from these periods. Parents recorded non-wear times at home in a diary while study staff recorded active play periods on the playground and in the muscle room, or gym, while in child care. The authors interpreted 120 consecutive epochs (30 min) with zero counts as non-wear time (Pfeiffer et al., 2006).

2.2.2.2. Screen time. Study staff recorded the presence of TVs and computers in the childcare and the minutes these devices were used by individual children. Screen time (including computers, TVs, and tablets) in the home was recorded by the parent. We assessed screen time use given their prevalence in US homes, including low-income populations (Kabali et al., 2015; Mobile Fact Sheet, 2018).

2.3. Analysis

Means and standard deviations and frequencies and percents were used to describe participant demographics, sleep, screen time and physical activity behaviors. Hierarchical linear regression models (HLM) and generalized estimating equations (GEE) were used to test for associations between race (Black, White, and Other including mixed race), outdoor and indoor active time, actual PA, daytime nap, and bedtime after 9 pm, and screen time in preschoolers aged 3 to 5 years attending full-day child care. HLMs were fit using restricted maximum likelihood with the Satterthwaite approximation for the degrees of freedom. Models included center as a random effect and fixed effect terms for model covariates. GEEs were estimated using a logit link function, center as the cluster term, a compound symmetry working correlation matrix, and robust standard errors. All models were multivariable and included the following covariates chosen a priori based on a review of the literature and subject matter knowledge: child sex, child age, low-income status (defined as eligible for free and reduced-price lunch in child care), single vs. couple status (regardless of marital status) day of the week and hours of daylight. Hours of daylight for each observation day were obtained from the Astronomical Applications Department of the U.S. Naval Observatory tables for daylight duration (Astronomical Applications Department). All analyses were conducted using SAS 9.3.

3. Results

Thirty randomly-selected child-care center directors agreed to participate with a 10% refusal rate. Two classrooms in each center were randomly selected with no refusals. Of the 570 potentially eligible children, 447 (77%) families gave consent to participate, and 415 children were present on the day of observation. A total of n = 380 children had complete sleep data. Of these, an additional n = 21 were missing data on at least one key covariate (n = 12 race, n = 15 income status, n = 16 single parent status) leaving a final n = 359 children available for analysis. Participant characteristics are described in Table 1. The demographics for the child participants were roughly evenly split with 51.5% female, 53.5% from a couple status home, and 56.6% classified as low-income. Racial categories for children were Black (39.6%), White (44.3%), and Other (16.2%).

3.1. Center time allotted for outdoor and indoor activity and actual PA

Childcare centers, on average, allotted mean (SD) of 73.9 (40.9) minutes for children to be active (Table 1). This time allotment included both outdoor time and gym time. Childcare centers allotted an average of 35.2 (38.8) minutes outdoors and an average of 38.8 (42.2) minutes in the gym as measured by study staff. Children accumulated an average of 314 (72.1) minutes spent in light activity and an average of 17 (12.8) minutes of moderate to vigorous PA over the 24 h period as measured by the accelerometer. Children accumulated an average of