Emergence of racial/ethnic differences in infant sleep duration in the first six months of life

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ABSTRACT

Objective: Examine the emergence of differences in sleep duration between infants from different racial/ethnic backgrounds and extent to which differences are explained by socioeconomic status (SES) and sleep continuity.
Methods: Sleep duration and continuity (number of night wakings and longest nighttime stretch of sleep) were assessed for 394 infants in the Rise & Sleep Health in Infancy & Early Childhood (SHINE) birth cohort at one- and six-months using the Brief Infant Sleep Questionnaire (BISQ). Multivariable regression was used to estimate associations of race/ethnicity with sleep duration adjusting for individual-level covariates, SES, and sleep continuity.
Results: The sample was 40% non-Hispanic white, 33% Hispanic, 11% Black, and 15% Asian. Mean (SD) durations for daytime, nighttime, and total sleep at one-month were 6.3 (2.0), 8.9 (1.5), and 15.2 (2.7) hours, respectively. Corresponding durations at six-months were 3.0 (1.4), 9.9 (1.3), and 13.0 (1.9) hours. At one-month, Hispanic infants had shorter nighttime sleep than white infants [β: −0.44 h (95% CI: −0.80, −0.08)]. At six-months, Hispanic [β: −0.96 h (−1.28, −0.63)] and Black [β: −0.60 h (−1.07, −0.12)] infants had shorter nighttime sleep than white infants. The near 1-h differential in night sleep among Hispanics resulted in shorter total sleep [β: −0.66 h (−1.16, −0.15)]. Associations across all racial/ethnic groups were attenuated after adjustment for SES at one- and six months. Sleep continuity attenuated associations with nighttime and total sleep duration by 20−60% for Hispanic infants at six-months.
Conclusions: Differences in sleep duration emerge early in life among racial/ethnic groups and are in part explained by SES and sleep continuity.

1. Introduction

Child sleep duration has decreased over the last century, with children sleeping 0.75 min less per year, on average, since 1905 [1]. Almost a third of children in the United States get an insufficient amount of sleep at least once per week [2]. The current recommended daily amount of sleep for children ranges from 9 to 17 h per day depending on age, with recommendations for infants 0−3 months and 4−11 months being 14−17 and 12−15 h, respectively [3]. A national survey by the National Sleep Foundation of

approximately 1500 parents in 2004 found that the average reported sleep duration for infants was 9.0 h, much lower than the recommended 12−15 h [4].

Both short- and long-term negative consequences of insufficient sleep in childhood have been consistently demonstrated. Insufficient sleep in infancy is associated with difficult temperament [5]. Among preschoolers and older children, insufficient sleep is associated with inattention, memory problems, hyperactivity, and other cognitive and behavioral deficits [5−7]. In addition, numerous studies have found that short sleep duration is a risk factor for increased body weight, a risk factor for Type 2 diabetes, and cardiovascular disease in children [8−13]. Finally, some research suggests that insufficient sleep in children is associated with increased stress and depression among parents [14].

The health implications of insufficient sleep, however, are not experienced equally across U.S. populations. As with other important lifestyle behaviors (eg, diet and physical activity) disparities in sleep have been identified such that adults from racial/ethnic minority and low socioeconomic (SES) backgrounds have shorter sleep durations [15−18]. Racial/ethnic disparities in children's sleep have also been reported, such that children from racial/ethnic minority backgrounds are reported to have the highest rates of insufficient sleep. Several studies [5,7,19−23] found disparities in both total and nighttime sleep duration by race/ethnicity as early as six-months which were maintained at one and two years of age with Black, Hispanic, and Asian children all exhibiting less sleep than white children. Racial/ethnic disparities in sleep problems and short sleep duration have also been observed [24,25].

Most previous studies examining differences in sleep duration across race/ethnicity have used a cross-sectional design, thus limiting the understanding of how differences change over time. Moreover, the age at which sleep disparities emerge is unclear, as only one study examined differences in infant sleep across race/ethnicity within the first year of life and did not examine sleep duration prior to six-months [5]. Studies have also typically focused on nighttime sleep or on total sleep duration, without considering day time sleep. The current study addresses these limitations by examining the emergence of differences in total, nighttime, and daytime infant sleep duration across race/ethnicity over the first six months of life and the extent to which any racial/ethnic differences can be explained by socioeconomic status or sleep continuity.

2. Methods

2.1. Subjects and study design

Subjects were participants in Rise & Sleep Health in Infancy & Early Childhood (SHINE), a birth cohort of mother-infant dyads that examines infant sleep patterns and growth in early life. Mothers were recruited after delivery and prior to discharge from the newborn unit of Massachusetts General Hospital in Boston, MA. Eligibility criteria for mothers included fluency in either English or Spanish, at least 18 years of age, biological and birthing mother of the infant, singleton birth, and no significant health conditions. Eligibility criteria for infants included healthy and full-term, with no genetic disorders or congenital malformations that could affect sleep or growth, receiving primary care from one of nine affiliated pediatric clinics, and the family living within 40 miles of Boston and with no plans to move from the area within the study period. After determining eligibility, research staff obtained consent from mothers and completed a brief intake survey. Home visits, when infants were approximately one-month and six-months, were conducted by two clinical research coordinators, lasted about an hour, and consisted of survey administration, and anthropometric measurements of both mothers and infants. Partners Health Care

Institutional Review Board approved the study procedures and materials.

In total, 448 mother-infant dyads (30% of those that were eligible) consented to be a part of the ongoing Rise & SHINE cohort. Consenting participants were more likely to be white (63% vs. 51%) and have a bachelor's degree (64% vs. 50%) than those who declined. The current analysis is based on a subset of the cohort, for which one- or six-month data were available as of an August 31, 2018 data freeze. Thus, the analytical samples include 394 dyads at one-month and 309 at six-months. Comparison of the one- and six-month samples revealed no differences in demographic characteristics between the groups. A complete-case sensitivity analysis (N = 306) was also conducted, and had minimal impact on the results, thus the larger samples were retained.

2.2. Main exposure

The main exposure was infant racial/ethnic background. Mothers reported their infant's ethnic background as whether or not it was Hispanic or Latino. Mothers then were then asked to classify their infant's racial background as white, Black or African American, Asian, American Indian or Alaskan Native, Native Hawaiian or other Pacific Islander, and/or other. Hispanic and multiracial infants were classified using the rarest group method, in which individuals are classified as belonging to the racial/ethnic group they identified that is rarest or least common. This method increases the power to detect differences between groups that are often underrepresented in health data [26].

2.3. Main outcome

The primary outcomes were mothers' report of their infant's average total, nighttime, and daytime sleep duration (in hours) at approximately one- and six-months of age. Nighttime and daytime sleep duration were collected using the following survey questions slightly modified from the Brief Infant Sleep Questionnaire (BISQ): "How much total time does your baby spend sleeping during the night (between seven in the evening and eight in the morning)?" and "How much total time does your baby spend sleeping during the day (between eight in the morning and seven in the evening)?" The BISQ is a widely used sleep measurement tool that has been validated against both actigraphy and daily sleep logs [27]. Total sleep duration was calculated by summing the reported nighttime and daytime sleep durations.

2.4. Other measures

We abstracted infant sex, gestation duration, and birthweight from electronic health records, while additional demographics for the sample were obtained from survey data. Mothers reported their infant's breastfeeding status at both one- and six-months. We dichotomized breastfeeding status as any versus none. Measures of socioeconomic status included maternal educational attainment and annual household income. We categorized maternal educational attainment as less than a bachelor's degree or a bachelor's degree and beyond. Annual household income was categorized using the U.S. Department of Housing and Urban Development's low-income limit for a family of 3−4 in the Boston area in 2018 which was defined as <$80,000 per year. Two aspects of sleep continuity, namely the number of times the infant typically wakes during the night and the longest stretch of time (in hours) that the infant is asleep without waking up during the night, were also assessed. Number of night wakings was measured using a single BISQ item, while longest stretch of sleep was measured using a single item from the expanded version of the BISQ [27].

2.5. Statistical analysis

We first examined the bivariate relationships of infant racial/ethnic background with sociodemographic characteristics, potential confounders, and the sleep outcomes; multicollinearity among the independent variables was minimal. We then used multiple linear regression models to assess the independent associations of racial/ethnic background on our primary outcomes of interest: total, nighttime, and daytime sleep duration (in hours/day) at one- and six-months of age. Multivariable linear regression models were used to assess the independent, main associations of racial/ethnic background at each time point adjusting for infant sex, gestation duration, birthweight, and breastfeeding status in Model 1. Because maternal education and annual household income could be confounders of the relationship between race/ethnicity and sleep duration, Model 2 further adjusted for these variables. In Model 3, we simultaneously adjusted for number of night waking and longest stretch of sleep, two variables representing aspects of sleep continuity, in addition to the variables included in Model 2. The purpose of this was to examine the extent to which more or less disrupted sleep explained differences in sleep duration across race/ethnicity.

3. Results

The racial/ethnic composition of the sample was 40% non-Hispanic white (N = 158), 33% Hispanic (N = 131), 11% Black (N = 44), and 15% Asian (N = 60). The majority of mothers were married (N = 306, 78%) and had at least a bachelor's degree (N = 266, 67%). Additional demographics are displayed in Table 1.

Mean (SD) durations for daytime, nighttime, and total infant sleep duration at one-month were 6.3 (2.0), 8.9 (1.5), and 15.2 (2.7) hours, respectively. Corresponding durations at six-months were 3.0 (1.4), 9.9 (1.3), and 13.0 (1.9) hours. The average number of night wakings at one-month was 2.6 (1.1), which decreased to 1.8 (1.2) at six-months. The longest stretch of sleep at one-month was 3.8 h (1.2), which increased to 6.8 h (2.5) at six-months Table 2 displays average sleep duration and continuity estimates across racial/ethnic groups.

Table 1
Sample demographics, overall and by infant race/ethnicity.

Infant Characteristics	Overall (N = 394)	NH White (N = 158)	Hispanic (N = 131)	Black (N = 44)	Asian' (N = 60)	P
Sex						0.65
Male	193 (49)	81 (51)	58 (44)	22 (50)	31 (52)	
Female	201 (51)	77 (49)	73 (56)	22 (50)	29 (48)	
Gestation duration" (weeks)	39.5 (1.0)	39.7 (1.0)	39.5 (1.0)	39.1 (1.1)	39.5 (1.1)	<0.01
Birthweight" (lbs)	7.4 (0.9)	7.6 (1.0)	7.5 (0.9)	7.2 (1.0)	7.1 (0.8)	<0.01
Breastfeeding at 1-month						0.02
Exclusive	172 (43)	100 (63)	31 (24)	14 (32)	26 (43)	
Partial	180 (46)	48 (31)	81 (62)	21 (48)	30 (50)	
None	42 (11)	10 (6)	19 (14)	9 (20)	4 (7)	
Breastfeeding at 6-months'''						<0.01
Exclusive	112 (36)	54 (43)	26 (26)	9 (28)	22 (47)	
Partial	90 (29)	41 (32)	26 (26)	8 (25)	15 (32)	
None	104 (34)	32 (25)	47 (48)	15 (47)	10 (21)	
Mother Characteristics						
U.S. Born	182 (46)	121 (76)	30 (23)	15 (34)	16 (27)	<0.01
Preferred Language						<0.01
English	306 (78)	155 (98)	56 (43)	38 (86)	56 (93)	
Other	88 (22)	3 (2)	75 (57)	6 (14)	4 (7)	
Marital Status						<0.01
Married	306 (78)	147 (93)	75 (57)	28 (64)	55 (91)	
Not married, living together	60 (15)	10 (6)	38 (29)	8 (18)	4 (7)	
Not married, living separate	27 (7)	1 (1)	18 (14)	7 (16)	1 (2)	
Number of Children						<0.01
1	198 (50)	93 (59)	55 (42)	15 (34)	35 (58)	
2	141 (36)	53 (33)	43 (33)	21 (48)	24 (40)	
3+	55 (14)	12 (8)	33 (25)	8 (18)	1 (2)	
Pre-pregnancy BMI (kg/m^2)						<0.01
<18.5 (Underweight)	6 (2)	0 (0)	2 (2)	0 (0)	4 (7)	
18.5−24.9 (Healthy weight)	221 (57)	116 (74)	45 (35)	16 (38)	44 (74)	
25−29.9 (Overweight)	75 (19)	23 (15)	34 (26)	10 (24)	7 (12)	
>30 (Obese)	85 (22)	17 (11)	48 (37)	16 (38)	4 (7)	
Past Year Employment Status						<0.01
Full-time	246 (63)	120 (76)	63 (48)	20 (45)	42 (70)	
Part-time	67 (17)	25 (16)	27 (21)	9 (20)	6 (10)	
Not employed	72 (18)	11 (7)	38 (29)	13 (30)	10 (17)	
Student	9 (2)	2 (1)	3 (2)	2 (5)	2 (3)	
Highest Level of Education						<0.01
<Bachelor's degree	128 (33)	13 (8)	86 (66)	26 (60)	2 (3)	
Bachelor's degree	95 (24)	47 (30)	26 (20)	9 (20)	13 (22)	
Graduate degree	171 (43)	98 (62)	19 (14)	9 (20)	45 (75)	
Annual Household Income						<0.01
<$30k	81 (21)	5 (3)	53 (42)	16 (38)	7 (12)	
$30−80k	79 (21)	18 (12)	41 (32)	14 (33)	5 (9)	
$80−200k	121 (31)	61 (39)	25 (20)	10 (24)	25 (43)	
>$200k	102 (27)	71 (46)	8 (6)	2 (5)	21 (36)	

NH: Non-Hispanic; ': 3 also identified as American Indian or Alaskan Native, and another as Native Hawaiian or other Pacific Islander; ": mean (SD) presented, as opposed to N (%); ''': percent denominators include only those with six-month data; multiracial infants were categorized using the rarest group method; 1 mother refused/didn't know her infant's race/ethnicity; marital status was missing for one mother, pre-pregnancy BMI was missing for 7, and annual household income was missing for 11; p-value is for race/ethnicity joint hypothesis test comparing non-Hispanic white infants to Hispanic, Black, and Asian infants.

Table 2
Sleep outcome descriptive statistics at one- and six-months, overall and by infant race/ethnicity.

	Duration	Overall (N = 394)	NH White (N = 158)	Hispanic (N = 131)	Black (N = 44)	Asian (N = 60)
1-month	Total Duration'	15.2 (2.7)	15.3 (2.3)	14.9 (2.9)	15.4 (3.1)	15.4 (2.7)
	Night Duration	8.9 (1.5)	9.0 (1.4)	8.6 (1.6)	8.8 (1.8)	9.2 (1.4)
	Day Duration'	6.3 (2.0)	6.3 (1.7)	6.2 (2.2)	6.4 (2.4)	6.3 (1.8)
	Continuity					
	Number of Night Wakings	2.6 (1.1)	2.5 (1.0)	2.5 (1.2)	2.5 (0.9)	2.9 (1.3)
	Longest Stretch of Sleep	3.8 (1.2)	3.9 (1.2)	3.9 (1.2)	3.4 (1.1)	3.6 (1.2)
	Duration	**Overall (N = 309)**	**NH White (N = 128)**	**Hispanic (N = 100)**	**Black (N = 33)**	**Asian (N = 47)**
6-months	Total Duration	13.0 (1.9)	13.3 (1.6)	12.6 (2.1)	13.0 (2.5)	12.7 (1.6)
	Night Duration	9.9 (1.3)	10.4 (1.1)	9.4 (1.3)	9.7 (1.3)	10.1 (1.2)
	Day Duration	3.0 (1.4)	3.0 (1.1)	3.2 (1.6)	3.2 (2.0)	2.6 (1.2)
	Continuity					
	Number of Night Wakings	1.8 (1.0)	2.0 (1.0)	1.7 (0.9)	1.8 (1.0)	1.8 (0.8)
	Longest Stretch of Sleep	6.8 (2.5)	7.0 (2.7)	6.8 (2.2)	7.0 (2.8)	6.0 (2.3)

Mean (SD); one mother refused/didn't know her infant's race/ethnicity; ': two mothers (<1%) had missing day sleep duration and therefore total duration at one-month.

Tables 3 and 4 show the results of the bivariate and multivariable linear regression models for total, nighttime, and daytime sleep duration at one- and six-months, respectively. In bivariate analyses we found that infants living in households with annual incomes <$80k compared to ≥$80k had shorter total and nighttime sleep duration at both one- [β: −0.69 h (95% Confidence Interval [CI]: −1.23, −0.14) and β: −0.38 h (95% CI: −0.70, −0.07), respectively] and six-months [β: −0.59 h (95% CI: −1.03, −0.16) and β: −0.75 h (95% CI: −1.03, −0.46), respectively]. At six-months, infants with mothers who did not graduate college had shorter nighttime sleep [β: −0.66 h (95% CI: −1.04, −0.29)] than those with mothers who did graduate college.

Bivariate analyses also showed associations between sleep continuity variables and infant sleep duration. At one-month, number of night wakings was associated with greater daytime sleep [β: 0.22 h (95% CI: 0.04, 0.40)], while longest stretch of sleep was associated with greater nighttime sleep [β: 0.33 h (95% CI: 0.21, 0.45)]. At six-months, longest stretch of sleep was associated with greater total [β: 0.19 h (95% CI: 0.11, 0.27)] and nighttime [β: 0.13 h (95% CI: 0.07, 0.18)] sleep duration, while no associations were found between number of night wakings and infant sleep duration.

In multivariate analyses, we observed differences in nighttime sleep duration among Hispanic infants as early as one-month. Hispanic infants slept approximately a half hour less at night

Table 3
Multivariable adjusted associations of race/ethnicity and socioeconomic characteristics with sleep duration at one-month.

	Unadjusted	Model 1	Model 2	Model 3
Total Duration				
Race/ethnicity		**P = 0.39**	**P = 0.57**	**P = 0.51**
Hispanic	−0.40 (−1.01, 0.22)	−0.39 (−1.02, 0.23)	1−0.11 (−0.89, 0.66)	−0.02 (−0.80, 0.76)
Black	0.13 (−0.76, 1.01)	0.16 (−0.75, 1.07)	0.49 (−0.51, 1.49)	0.67 (−0.34, 1.68)
Asian	0.17 (−0.62, 0.96)	0.22 (−0.58, 1.02)	0.30 (−0.52, 1.12)	0.22 (−0.61, 1.06)
Socioeconomic Status				
<College graduate	−0.30 (−0.97, 0.37)		0.36 (−0.49, 1.21)	0.32 (−0.54, 1.18)
Income <$80k	−0.69 (−1.23, −0.14)		−0.78 (−1.50, −0.07)	−0.90 (−1.62, −1.65)
Sleep Continuity				
Night wakings	0.12 (−0.12, 0.37)			0.24 (−0.05, 0.53)
Longest stretch	0.20 (−0.02, 0.41)			0.39 (0.11, 0.67)
Night Duration				
Race/ethnicity		**P = 0.03**	**P = 0.17**	**P = 0.08**
Hispanic	−0.43 (−0.79, −0.08)	−0.44 (−0.80, −0.08)	−0.40 (−0.85, 0.05)	−0.41 (−0.85, 0.02)
Black	−0.25 (−0.77, 0.26)	−0.22 (−0.75, 0.30)	−0.10 (−0.68, 0.48)	0.11 (−0.46, 0.68)
Asian	0.14 (−0.32, 0.59)	0.19 (−0.28, 0.65)	0.20 (−0.28, 0.67)	0.21 (−0.26, 0.68)
Socioeconomic Status				
<College graduate	−0.14 (−0.52, 0.25)		0.33 (−0.17, 0.82)	0.25 (−0.23, 0.73)
Income <$80k	−0.38 (−0.70, −0.07)		−0.31 (−0.72, 0.10)	−0.32 (−0.73, 0.09)
Sleep Continuity				
Night wakings	−0.11 (−0.25, 0.03)			0.12 (−0.04, 0.28)
Longest stretch	0.33 (0.21, 0.45)			0.45 (0.29, 0.61)
Day Duration				
Race/ethnicity		**P = 0.76**	**P = 0.55**	**P = 0.50**
Hispanic	0.00 (−0.46, 0.47)	0.02 (−0.45, 0.49)	2 0.24 (−0.34, 0.82)	0.34 (−0.25, 0.92)
Black	0.36 (−0.32, 1.03)	0.36 (−0.33, 1.04)	0.55 (−0.20, 1.30)	0.51 (−0.24, 1.27)
Asian	0.01 (−0.59, 0.61)	0.00 (−0.60, 0.61)	0.06 (−0.55, 0.68)	−0.02 (−0.64, 0.61)
Socioeconomic Status				
<College graduate	−0.17 (−0.68, 0.33)		0.02 (−0.62, 0.67)	0.06 (−0.58, 0.71)
Income <$80k	−0.29 (−0.70, 0.11)		−0.43 (−0.97, 0.11)	−0.54 (−1.09, 0.01)
Sleep Continuity				
Night wakings	0.22 (0.04, 0.40)			0.11 (−0.11, 0.33)
Longest stretch	−0.13 (−0.29, 0.04)			−0.05 (−0.26, 0.16)

β [95% CI]; Model 1 adjusts for sex, gestational length, birthweight, and breastfeeding status; Model 2 additionally adjusts for socioeconomic status (maternal education and annual household income), and Model 3 additionally adjusts for sleep continuity (number of night wakings and longest stretch of sleep); referent groups for race/ethnicity is non-Hispanic white, for education is college graduate, and for annual household income is $80k+. p-value is for race/ethnicity joint hypothesis test for linear trend.

Table 4
Multivariable adjusted associations of race/ethnicity and socioeconomic characteristics with sleep duration at six-months.

	Unadjusted	Model 1	Model 2	Model 3
Total Duration				
Race/ethnicity		*P = 0.04*	*P = 0.14*	*P = 0.51*
Hispanic	−0.73 (−1.22, −0.23)	−0.66 (−1.16, −0.15)	3−0.48 (−1.12, 0.15)	−0.21 (−0.91, 0.49)
Black	−0.31 (−1.03, 0.41)	−0.17 (−0.91, 0.57)	0.07 (−0.75, 0.89)	−0.64 (−1.62, 0.33)
Asian	−0.66 (−1.29, −0.03)	−0.64 (−1.29, 0.00)	−0.59 (−1.24, 0.06)	−0.37 (−1.04, 0.31)
Socioeconomic Status				
<College graduate	−0.25 (−0.82, 0.31)		0.32 (−0.39, 1.02)	0.18 (−0.64, 1.00)
Income <$80k	−0.59 (−1.03, −0.16)		−0.54 (−1.10, 0.03)	−0.41 (−1.01, 0.20)
Sleep Continuity				
Night wakings	0.10 (−0.15, 0.35)			0.42 (0.08, 0.75)
Longest stretch	0.19 (0.11, 0.27)			0.29 (0.13, 0.45)
Night Duration				
Race/ethnicity		*P < 0.01*	*P < 0.01*	*P = 0.06*
Hispanic	−0.99 (−1.31, −0.67)	−0.96 (−1.28, −0.63)	4−0.76 (−1.17, −0.35)	−0.60 (−1.06, −0.14)
Black	−0.65 (−1.12, −0.19)	−0.60 (−1.07, −0.12)	−0.30 (−0.83, 0.22)	−0.58 (−1.22, 0.06)
Asian	−0.29 (−0.69, 0.12)	−0.30 (−0.72, 0.11)	−0.28 (−0.70, 0.13)	−0.20 (−0.64, 0.25)
Socioeconomic Status				
<College graduate	−0.66 (−1.04, −0.29)		0.03 (−0.42, 0.48)	0.20 (−0.33, 0.74)
Income <$80k	−0.75 (−1.03, −0.46)		−0.39 (−0.75, −0.04)	−0.35 (−0.75, 0.04)
Sleep Continuity				
Night wakings	0.10 (−0.07, 0.27)			0.34 (0.12, 0.55)
Longest stretch	0.13 (0.07, 0.18)			0.24 (0.13, 0.34)
Day Duration				
Race/ethnicity		*P = 0.04*	*P = 0.18*	*P = 0.29*
Hispanic	0.26 (−0.10, 0.63)	0.30 (−0.08, 0.68)	5 0.27 (−0.20, 0.75)	0.39 (−0.13, 0.91)
Black	0.35 (−0.19, 0.88)	0.42 (−0.13, 0.97)	0.37 (−0.24, 0.98)	−0.06 (−0.79, 0.66)
Asian	−0.37 (−0.84, 0.10)	−0.34 (−0.82, 0.14)	−0.31 (−0.79, 0.17)	−0.17 (−0.67, 0.33)
Socioeconomic Status				
<College graduate	0.41 (0.00, 0.83)		0.29 (−0.24, 0.81)	−0.02 (−0.63, 0.59)
Income <$80k	0.15 (−0.17, 0.48)		−0.14 (−0.56, 0.28)	−0.05 (−0.51, 0.40)
Sleep Continuity				
Night wakings	0.00 (−0.18, 0.18)			0.08 (−0.17, 0.33)
Longest stretch	0.06 (0.00, 0.13)			0.05 (−0.07, 0.17)

β [95% CI]; Model 1 adjusts for sex, gestational length, birthweight, and breastfeeding status; Model 2 additionally adjusts for socioeconomic status (maternal education and annual household income), and Model 3 additionally adjusts for sleep continuity (number of night wakings and longest stretch of sleep); referent groups for race/ethnicity is non-Hispanic white, for education is college graduate, and for annual household income is $80k+. p-value is for race/ethnicity joint hypothesis test for linear trend.

compared to white infants [β: −0.44 h (95% CI: −0.80, −0.08)] after adjustment for sex, gestation duration, birthweight, and breastfeeding status (Model 1). The association was minimally attenuated after adjustment for SES (9%; Model 2) and sleep continuity (3%; Model 3). No other racial/ethnic differences in sleep duration were observed in nighttime sleep at one-month.

At six-months, Hispanic infants slept approximately 1-h less at night compared to white infants [β: −0.96 (95% CI: −1.28, −0.63)], while Black infants slept 36 min less [β: −0.60 h (95% CI: −1.07, −0.12)] adjusting for sex, gestation duration, birthweight, and breastfeeding status. Estimates for Hispanic infants were attenuated by 21% [β: −0.76 h (95% CI: −1.17, −0.35)] after further adjustment for SES, and by 21% [β: −0.60 h (95% CI: −1.06, −0.14)] after adjustment for sleep continuity. The association for Black infants was attenuated by 50% [β: −0.30 h (95% CI: −0.83, 0.22)] after adjusting for SES, but was strengthened by 55% [β: −0.58 h (95% CI: −1.22, 0.06)] adjusting for sleep continuity.

We also observed differences across race/ethnicity for total sleep duration at six-months, with Hispanic infants having shorter total sleep durations than non-Hispanic white infants in multivariate adjusted models [β: −0.66 h (95% CI: −1.16, −0.15)]. Among Hispanic infants, the association with shorter total sleep duration was attenuated by 27% [β: −0.48 h (95% CI: −1.12, 0.15)] after adjusting for SES and by 56% [β: −0.21 h (95% CI: −0.91, 0.49)] after adjusting for sleep continuity. Asian infants also had shorter total sleep durations than their white counterparts [β: −0.64 h (95% CI: −1.29, 0.00)].

For daytime sleep duration, we observed an overall combined effect of race/ethnicity (p = 0.04) with positive but non-significant coefficients observed for Hispanic and Black infants.

4. Discussion

In this prospective cohort of infants, Hispanic children slept substantially less at night than non-Hispanic white children at both one- and six-months of age, with larger differences observed at six-months. Black infants also slept less than their white counterparts at six-months. Observed differences in sleep duration across race/ethnicity were independent of sex, gestational length, birthweight, and breastfeeding status. Adjustment for socioeconomic status partially attenuated associations of race/ethnicity and sleep duration among Hispanic and Black children at six months. Associations among Hispanic infants with nighttime and total sleep duration at six-months were substantially attenuated after adjustment for sleep continuity.

The findings from this study are consistent with the previous literature on racial/ethnic differences in sleep in childhood [5,7,19,20,24,28]. We observed significant differences in total, nighttime, and daytime sleep durations between white and racial/ethnic minority infants. Even with relatively small sizes for the Black and Asian groups, similar to findings by Nevarez et al., [24]; we found significant differences at six-months compared to non-Hispanic white infants. This study advances the literature by examining differences in sleep duration by race/ethnicity as early as one-month of age. The presence of significant differences in nighttime sleep duration across racial/ethnic groups at one-month suggests that disparities may be present from birth; therefore, infant sleep hygiene interventions may need to target mothers during pregnancy to be most effective. Further studies investigating the contributing factors and mechanisms by which differences in sleep outcomes develop are needed to inform intervention targets and timelines.

This study also included multiple measures of sleep duration and are in line with [5]; which showed that while Hispanic, Black, and Asian infants had significantly shorter nighttime sleep durations at six-months compared to white infants, they had longer daytime sleep durations. Hispanic and Black infants may be compensating for shorter nighttime sleep at six-months by napping during the day (or conversely sleeping less at night due to less homeostatic drive due to greater daytime sleep). However, even with slightly longer daytime sleep durations, we still observed significantly shorter total sleep durations among Hispanic infants. Finally, results from this study add to the small pool of studies that measure sleep at multiple time points adjusting for various covariates [19,24]. The design of this study allowed for an assessment of how the association between racial/ethnic background and sleep duration changes over time. Based on the results, differences in sleep duration across ethnicity appear to widen from one-month of age to six-months, further supporting the importance of early intervention. This finding may be indicative of an ongoing divergence of sleep patterns with development but could also be reflective of less measurement error at six-months compared to one-month.

Following recommendations for studies of racial/ethnic disparities for various infant outcomes, we assessed the effect of socioeconomic status (SES) using two measures: maternal education and annual household income [29]. Similar to Ref. [19,24] we found that ethnic differences in sleep duration cannot be fully explained by these sociodemographic variables, and that they persist over time. Household income and maternal education contributed, but did not fully explain, differences in sleep duration. Nonetheless, consistent with other studies, infants from low-SES households had shorter total and nighttime sleep durations at one- and six-months [7,29−31]. Differences in infant sleep duration by race/ethnicity and SES may be the result of parenting practices (eg, putting the infant to bed asleep as opposed to drowsy, lack of a bedtime routine, or later bedtimes) or aspects of the social (eg, maternal mental health or family stress) or sleep environment (eg, television in the bedroom) [4,5,22,24,32−35]. Biological factors may also contribute, and there may be significant interactions between race/ethnicity and SES on infant sleep outcomes. Due to relatively small sample sizes, we were unable to examine interactions in this study, but future studies should investigate the potential double disparity among individuals who are both racial/ethnic minorities and low SES, as well as contributing factors, particularly those which are modifiable.

Beyond socioeconomic status, we also explored associations between sleep continuity and sleep duration in an attempt to better understand racial/ethnic differences in sleep duration. Sleep duration may be prolonged if sleep is less restorative due to multiple wakings. Consolidation of sleep is shaped by neurodevelopmental processes that may be influenced by biological processes, hunger and satiety, as well as by aspects of the environment that influence consolidated sleep such as light and noise. A study by El-Sheikh et al. [30], found that children from more economically disadvantaged backgrounds had relatively worse sleep continuity, suggesting that sleep disparities in childhood may extend beyond duration. We also observed some differences in sleep continuity across racial/ethnic groups, as well as differences in the relationships of sleep continuity and sleep duration. At one-month, mothers of Asian infants reported more frequent night wakings compared to white infants and at six-months they reported shorter stretches of uninterrupted sleep. Black infants had shorter stretches of uninterrupted sleep at one-month compared to white infants. At six-months, Hispanic infants had fewer night wakings than white infants. Moreover, differences in sleep continuity explained a portion of the differences in nocturnal sleep in Hispanic infants at both one- and six-months. Further research is needed to better understand interacting influences, such as quality, timing, consolidation, regularity, and circadian alignment, on sleep behaviors. Further research is also needed to investigate how differences in characteristics of sleep hygiene may contribute to, or be associated with, differences in sleep disorder symptomology and diagnoses across race/ethnicity.

The present study had several strengths, including multiple and repeated measures of infant sleep duration, adjustment for various covariates, including SES as a potential confounder, and aspects of sleep continuity as potential explanatory variables. However, the study was not without limitations. We used mother reported infant sleep estimates as opposed to validated objective measures. Results may have been influenced by measurement error. While this influence is likely to result in random misclassification, it is possible that differential reporting across racial/ethnic or SES groups may have led to systematic error or bias. For example, mothers belonging to certain subgroups, or mothers exhibiting certain sleep parenting behaviors (eg, co-sleeping) may be more or less aware of their infant's sleep and wake patterns, and this may have resulted in systematic bias. We classified race/ethnicity using the rarest group method [26]. Racial/ethnic classification is a complex task due to the heterogeneity and social and cultural complexity of groups, and method of classification could have important implications for the results [15,26]. Finally, a large proportion of the sample was highly educated, and thus the results may not be generalizable to all populations.

5. Conclusions

This study revealed that differences in sleep duration across race/ethnicity are present as early as the first month of life and widen by six-months. Socioeconomic variables only partially explained the decreased nighttime sleep duration of Hispanic and Black infants at six-months compared to white infants. Differences in sleep continuity contributed to differences in nighttime sleep duration between Hispanic and white infants at both one- and six-months. The considerable health consequences of insufficient sleep, coupled with the many other health problems racial/ethnic minorities are at increased risk for, highlight the need for further research investigating the mechanisms by which sleep disparities in early life emerge, to inform intervention efforts that equitably promote good sleep hygiene in infants.

Conflict of interest

None.
The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleepx.2019.100003.

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