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## Sociodemographic and environmental factors associated with childhood sleep duration

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### Abstract

**Objectives:** This study investigates sociodemographic and environmental correlates of sleep duration among school-aged children.

**Design & Setting:** The New York City 2009 Child Community Health Survey was analyzed using weighted regression analyses.

**Participants:** 1293 Asian, Black, Latino and White children ages 6–12 years, 999 children in Pre-K – 5th grade and 294 children in the 6th-8th grades.

**Measurements:** Parents/guardians completed a survey about the target child's sleep duration on a typical school night/day, and sociodemographic and household characteristics.

**Results:** Most children (89.3%) met the National Sleep Foundation's (NSF) recommendation of 9–11 h of sleep per night. Pre-K-5th grade children who were born in the United States were less likely than children born outside of the United States to sleep 9–11 h. When sleep duration was examined continuously, children slept an average of 9 h 44 min. On average, with each additional year of age, children slept 7.2 min less than children who were one year younger. Although there were no differences among ethnic/racial groups in sleeping the recommended 9–11 h/night, when sleep duration was measured as a continuous variable, Asian, Latino, and Black children slept an average of 23, 14, and 17 min fewer, respectively, than White children, adjusting for sociodemographic and environmental factors.

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Conflicts of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

**Conclusions:** Sleep duration varied across sociodemographic groups of children in New York City in 2009. Future studies should determine causal influences and whether these differences persist.

### Keywords

Children; Ethnicity/race; Disparities; Sleep duration

Sleep is a complex biological necessity influenced by sociodemographic and environmental factors, and it is fundamental for the health and functioning of all individuals. For young children and adolescents, sleep is essential for optimal socioemotional and academic development<sup>1,2</sup>. This study investigates sociodemographic (e.g., age, sex/gender, ethnicity/race, nativity, family socioeconomic status) and environmental (e.g., crowding, having a smoker in the home) factors associated with childhood sleep duration among children in New York City in 2009. Factors of interest were informed by prior work linked to sleep duration. Among sociodemographic variables, age-related decreases in sleep duration have been attributed to biological changes, increased academic demands, and increased autonomy<sup>3,4</sup>. While some research has observed sex/gender differences in sleep<sup>5</sup>, there is also research which has not observed differences<sup>3</sup>. Nativity has been found to be related to sleep, with United States-born individuals having shorter sleep<sup>6,7</sup>. In addition, family socioeconomic status (SES) has also been implicated to be associated with sleep duration<sup>8–10</sup>. Black and Latino children and adults report shorter sleep duration and poorer quality sleep relative to Whites.<sup>4,11,12</sup> There is also research to suggest sleep disparities between Asian and White communities<sup>13,14</sup>. This study also investigates environmental correlates that have been observed to compromise sleep, such as crowding in the home which leads to stress<sup>15</sup> and has been suggested to disturb childhood sleep duration<sup>16</sup>. The presence of a smoker in the home has also been observed to impact childhood sleep<sup>17–20</sup>. Because we focus on sleep duration, we adjust for sleep-related covariates such as sleep quality<sup>21</sup> and sleep hygiene (i.e., having a regular bedtime<sup>13</sup> and media use<sup>22</sup>). Finally, we also control for health-related covariates such as physical activity, health history, asthma, early intervention status, and adult respondent health in the analyses<sup>23</sup>.

This study contributes to the literature on sleep health in several important ways. First, it contributes to health disparities research by considering the relative, independent association between sociodemographic and environmental factors with childhood sleep duration in a large, diverse, and representative sample of children ages 6–12 years in New York City. While research has explored the links between each of these variables and sleep duration, few have explored their relative associations in a large and representative dataset. Therefore, the current study contributes to research on sleep duration by investigating if previously observed effects may be attributed to shared variance with other factors (e.g., residential crowding effects explained by SES). Informed by prior work, we hypothesize age-related declines in sleep duration<sup>24,25</sup>. In addition, we hypothesize ethnic/racial differences in children's sleep, with Asian, Black, and Latino children sleeping less than their White counterparts<sup>3,13,14</sup>. We also hypothesize shorter sleep duration for children from lower SES families<sup>8–10</sup>, and shorter duration for United-States-born youth than foreign born youth<sup>6,7</sup>. Finally, based on the existing research<sup>16,18</sup>, we expect that residential crowding and living

with a smoker are negatively associated with sleep duration. The second contribution is that sleep duration is modeled as both a continuous and a dichotomous variable (i.e., whether children are sleeping the National Sleep Foundation (NSF)-recommended 9–11 h per night for this age group)<sup>26</sup>. Including both indicators of sleep duration maximizes the relevance of the research, recognizing that some members of the sleep science community may be interested in sleep duration as a continuous variable situating the current work in a larger scientific framework, while applied scientists and practitioners may be more interested in sleep duration as a dichotomous variable for the policy relevance of this work.

## Methods

### Participants

The study is a secondary analysis of a representative sample of 3002 children ages 0–12 years residing in New York City whose parent/guardian participated in the Child Community Health Survey conducted by the New York City Health Department and Mental Hygiene (NYC DOHMH) between April and December 2009<sup>27</sup>. The data are weighted to represent the New York City population of children based on the 2006–2008 American Community Survey data<sup>27</sup>. Survey data were collected for two age groups: 0–5 years and 6–12 years. The current study focuses on the 6–12-year-olds since sleep questions were only administered to this group. Because school start and dismissal schedules become more standardized starting in kindergarten, children between ages 6–12 who were enrolled in school (including 79 children who were in Pre-K and kindergarten) were retained for analysis ( $n = 1459$ ). Although the National Sleep Foundation recommends 9–11 h of sleep per night for this age group, sleeping up to 12 h at this age is also considered normative<sup>33</sup>. In the current sample, 53 youth were reported as sleeping >11 h (4% of the analytic sample). In the unweighted data, most of the children who were reported to sleep >11 h were young children (average age = 7.53, SD = 1.69; 6 years old = 39.62%, 7 years old = 18.87%, 8 years old = 15.09%, 9 years old = 11.32%, 10 years old = 9.43%, 11 years old = 1.89%, 12 years old = 3.77%). Among these children, approximately 47.2% were boys and 52.8% were girls. All ethnic/racial groups were represented (37.74% White, non-Hispanic, 22.64% Black, non-Hispanic, 33.96% Hispanic, 1.89% Asian/PI, non-Hispanic, and 3.77% other, non-Hispanic) and most were born in the United States (92.45%). To keep the results interpretable within the context of the NSF's 9–11 h guideline, we opted to exclude these children from the primary analyses. However, to investigate how the exclusion of these youth influence the results, we also conduct sensitivity analyses to compare results with the inclusion of these youth. Since ethnicity/race was a sociodemographic variable of interest, children who were identified as “other, non-Hispanic race ( $n = 43$ )” were excluded due to lack of information regarding ethnicity/race. Additionally, children in high school ( $n = 2$ ), with missing school grade information ( $n = 13$ ), home-schooled/not enrolled in school ( $n = 16$ ) or not living with at least one parent ( $n = 52$ ) were excluded. The final analytic sample included 1293 children: 999 children in pre-K-5th grade and 294 children in 6th–8th grade.

## Procedure

Random-digit dialing and a computer-assisted telephone interviewing system were employed for data collection, and only families with landline phones were eligible. Eligible households were contacted via the random digit dial (RDD) landline sample from the 2009 Community Health Survey (CHS)<sup>28</sup> and a supplemental RDD landline sample. The CHS is an annual health survey conducted by NYC DOHMH to better understand the health and risk behaviors among New York City adults. Details of the CHS methodology have been described elsewhere<sup>28</sup>. In 2009 CHS, respondents who reported having children ages 0–12 in the household were invited to participate in the child health survey<sup>27</sup>. A knowledgeable adult (i.e., parent or guardian) living with a target child age 12 or below responded to a telephone survey (average completion = 23 min, 27% response rate for interviews recruited from the Community Health Survey; 48% response rate for interviews recruited from a supplemental Random Digit Dial sample). Ninety-one percent of respondents were parents of the target child (69% mothers, 22% fathers, 9% grandparent or other). Families completed the survey in English, Spanish, Russian or Chinese, and were offered \$30 for participating<sup>27</sup>.

Although the data are publicly available, access is granted with an approved Data Use Agreement submitted to the Bureau of Epidemiology Services, NYC DOHMH, detailing the planned analyses, specific variables, authors, and instructions to destroy the data. Since the data are de-identified, this research was deemed exempt by Fordham University Institutional Review Board.

## Measures

### Recommended sleep duration.

National Sleep Foundation (NSF) recommends 9–11 h for children ages 6–13<sup>26</sup>. A dummy variable was constructed (0 = sleeping < 9 h; 1 = sleeping 9–11 h).

### Sleep duration.

Sleep duration was measured continuously in hours and minutes based on adult respondent reports of when the target child goes to bed and wakes up on a typical school night/day.

### Sociodemographic characteristics.

Child's *ethnicity/race* was dummy coded as Asian, Black, Latino, with White children as the reference group. Child's *age* was measured in years. Child's *sex/gender* was coded as 0 = female or 1 = male, and child *nativity* was coded as 0 = foreign born or 1 = United States-born. *Parent nativity* was categorized as 0 = at least one parent born outside of the United States or 1 = both parents are United States-born. *Family SES* combined the highest level of education completed in the household (0 = less than high school, 1 = high school grad, 2 = some college, 3 = college grad) with the annual household income relative to the Federal Poverty Level (0 = < 100% FPL, 1 = 100 to 199% FPL, 2 = 200 to 399% FPL, 3 = 400 to 599% FPL, 4 = 600%+ FPL). Scores ranged from 0 to 7 with higher scores reflecting higher SES. *School type* was another indicator of SES and coded as 0 = private school or 1 = public.

### Environmental correlates.

*Crowding* was computed as a people-to-room ratio with higher scores indicating more crowding (i.e., more people to fewer rooms). Respondents were asked to indicate “how many rooms are in your home or apartment? Include kitchens, but exclude bathrooms, porches, balconies and foyers.” Having a *smoker in the home* (i.e., “How often does anyone smoke inside your home/apartment?” 1 = all or most of the time, 2 = only occasionally, and 3 = never) was dichotomized as 0 = no smoker and 1 = smoker.

### Covariates.

Variables associated with sleep duration were covaried in the analysis. First, we included the adult respondent’s report of the target child *sleeping through the night* (“Does [the target child] usually sleep through the night without waking?” 0=no, 1=sleep through night without waking) and having a regular *bedtime* (“During the past school year, did [the target child] have a regular bedtime?” 0 = no, 1 = has a regular bedtime). Child *media use* reflects the sum of leisure hours on an average weekday watching TV and on a computer (recoded 1 = none or less than 1 h; 2 = 1 h; 3 = 2–3 h; and 4 = 4 or more hours). Dummy variables for media use were created for 2 (1 h), 3 (2–3 h), and 4 (4 or more hours), with “1 = none or less than 1 h” as the reference group. *Physical activity* is the mean of the number of days that the target child was physically active in the past 7 days (e.g., practiced team sports, martial arts, dance). Child’s *health history* (“Has a doctor or other health care provider ever told you that [the target child] had [health condition]”) was dummy coded as 0 = none, 1 = ever having been diagnosed with at least one health condition, including ADHD, depression, anxiety, oppositional defiant disorder, conduct disorder, autism or other autism spectrum disorder, any developmental delays and learning disabilities. Given the impact of *asthma* on sleep, asthma status was dummy coded as 0 = no, 1 = ever having asthma as a separate variable, based on the adults’ responses on “Has a doctor or other health care provider ever told you that [the target child] had asthma?” Child’s need for *early intervention* (“Does [the target child] need or use more medical care or mental health services than is usual for most children of the same age?” “Does [the target child] have any developmental problem for which [he/she] needs or gets treatment or counseling?”) was dummy coded as 0=none, 1=needs or receives early intervention. *Adult health*—parent/respondent adult health— (“Would you say that in general your health is excellent, very good, good, fair, or poor?”) was categorized as 0 = fair/poor, good, 1 = good, 2 = very good, and 3 = excellent (the reference group).

### Analyses

Given age-related changes in sleep<sup>29</sup> and structural differences between elementary and middle school students (e.g., start times), analyses were conducted first for the full sample (i.e., 6–12 years), and separately for elementary-aged children (pre-K-5th). Separate analyses were not conducted for the 6th-8th grade children due to the smaller sample size. All analyses were conducted in Stata/SE 12.1. Prevalence estimates, logistic regression analyses of meeting the NSF 9–11 h recommendation, and ordinary least squares regression analyses of the amount of sleep as a continuous variable, were weighted to represent the population of children in New York City across the 5 boroughs, child age, gender, and

ethnicity/race. The weights account for sampling bias resulting from differential nonresponses and/or under-coverage of sample frame including those who were not in the random-digit dial sample frame because they could only be reached by cellular phone or did not have telephone service<sup>27</sup>. Missing values were below 10% for all variables. To test if missing values were associated with sociodemographic variables, missingness for the dependent variable (i.e., sleep duration) was coded “1” while non-missing values were coded “0.” Results suggested that missingness was not related to any sociodemographic variables (i.e., child’s age, sex/gender, nativity, ethnicity/race, or family SES) when the data were unweighted, which implied missing completely at random. Even when the data were weighted, missingness remained unrelated to sociodemographic variables with only one exception, child’s sex. Under these conditions, it was deemed appropriate to employ list-wise deletion<sup>30</sup>.

## Results

### Sample characteristics

Weighted and unweighted descriptive statistics for all measures are included in Table 1. Weighted descriptive statistics are representative of a total of approximately 620,000 children in New York City (Table 1): approximately 500,000 children between pre-K and 5th grade (6–12 years old; 80.65%), and 120,000 children between 6th and 8th grade (9–12 years old; 19.35%). Of the sample, 45.7% were girls and 54.3% were boys. The average sleep duration was 9 h, 44 min for the full sample (pre-K-5th: 9 hours, 50 minutes; 6th-8th grade: 9 hours, 21 minutes).

Bivariate correlation analyses (Table 2) showed that younger age, attending a private school, having a regular bedtime, less media use, more physical activity, and better adult health were correlated with longer sleep duration in hours. Similarly, younger age, having no smokers in the home, having a regular bedtime, less media use, and more physical activity were positively correlated with sleeping 9–11 hours per night.

The percentage of children sleeping 9–11 hours per night was 89.29% [95% CI: 86.90–91.70%]. Weighted multivariable logistic regressions considered sociodemographic and environmental correlates and covariates to predict whether or not children were meeting the NSF’s recommendation of 9–11 hours of sleep per night (Table 3)<sup>26</sup>. Then, weighted multivariable linear regression analyses estimated sociodemographic and environmental correlates of sleep duration in minutes (Table 4). The following section summarizes the results by sociodemographic characteristics, environmental correlates, and covariates for the 6–12 year-olds and for the Pre-K-5th grade children. The results are presented first for the dichotomous variable indicating whether children are sleeping 9–11 hours, and second for a continuous sleep variable.

### Sociodemographic characteristics and sleep duration

In the full sample of Pre-K-8th grade children (ages 6–12), there were no ethnic/racial differences in whether children were sleeping 9–11 hours per night. Older children were less likely to sleep 9–11 hours compared to younger children (OR = 0.71; 95% CI 0.61; 0.83; *p*



< .001; Table 3). As a continuous variable, Asian ( $b = -0.38$ ,  $SE = 0.12$ ,  $p < .01$ ; Table 4), Black ( $b = -0.28$ ,  $SE = 0.08$ ,  $p < .001$ ; Table 4), and Latino ( $b = -0.24$ ,  $SE = 0.08$ ,  $p < .01$ ; Table 4) children had shorter sleep duration than White children (Fig. 1). Sleep duration declined with age such that children slept an average of 7.2 fewer minutes with each additional year of age ( $b = 0.12$ ,  $SE = 0.01$ ,  $p < .001$ ; Table 4). Having a regular bedtime was associated with longer sleep duration ( $b = 0.68$ ,  $SE = 0.17$ ,  $p < .001$ , Table 4).

Among Pre-K-5th grade children, the odds of sleeping 9–11 h decreased with age (OR = 0.71, 95% CI = 0.58; 0.88,  $p < .01$ ; Table 3). Children born in the United States were less likely than children born outside of the United States to sleep 9–11 hours (OR = 0.12; 95% CI = 0.02; 0.85,  $p < .05$ ; Table 3). When investigating sleep duration as a continuous variable, Asian ( $b = -0.39$ ,  $SE = 0.13$ ,  $p < .01$ ), Black ( $b = -0.30$ ,  $SE = 0.08$ ,  $p < .001$ ), and Latino ( $b = -0.21$ ,  $SE = 0.08$ ,  $p < .01$ ) children had shorter sleep duration than White children (Table 4). White Pre-K-5th grade children's average sleep duration was 10 hours, 31 minutes, and Asian children slept 10 hours, 7 minutes (23 minutes less than White,  $SE = 8$  min), Black children slept 10 hours, 13 minutes (18 minutes less than White,  $SE = 5$  minutes), and Latino children slept 10 hours, 18 minutes (13 minutes less than White,  $SE = 5$  minutes). When exploring differences among the ethnic/racial minority youth, Bonferroni post-hoc pairwise comparisons revealed no differences between Asian, Black and Latino children (adjusted  $p = .05/6$  comparisons = .008).

### Environmental correlates and sleep duration

Neither crowding nor presence of a smoker in the home were identified as significant predictors of sleeping 9–11 hours (Table 3). There were also no associations between environmental correlates such as crowding or presence of a smoker in the household and sleep measured as a continuous variable for the full sample (Pre-K-8th grade; Table 4).

### Other covariates and sleep duration

However, having a regular bedtime was conducive to sleeping 9–11 hours compared to not having a regular bedtime (OR = 8.06; 95% CI = 3.42 to 19.02;  $p < .001$ ; Table 3). In the full sample (Pre-K-8th grade), children who spent 4+ hours/day on media use were less likely to sleep 9–11 hours compared to those who spent 0- <1 hours/day on media use (OR = 0.14, 95% CI = 0.03 to 0.64;  $p < .05$ ; Table 3). Physical activity was conducive to sleep; with an additional day of physical activity per week increasing the odds of sleeping 9–11 hours by 22% (OR = 1.22, 95% CI 1.03 to 1.45;  $p < .05$ ; Table 3). In hours, using media for 4+ or 2–3 hours/day was associated with shorter sleep duration compared to using media for 0- <1 hours/day (~10 hours 18 minutes, ~10 hours 28 minutes, ~10 h 41 minutes, respectively; Table 4).

For the younger Pre-K-5th grade children, compared to those without a regular bedtime, the odds of sleeping 9–11 hours for children with a regular bedtime was 8.26 (95% CI 2.53; 28.91;  $p < .001$ ; Table 3). In addition, compared to those who spent 0- <1 hours/day on media, children who spent 1 hours/day (OR = 0.10, 95% CI = 0.01; 0.82,  $p < .05$ ; Table 3), 2–3 hours/day (OR = 0.11, 95% CI = 0.01; 0.78,  $p < .05$ ; Table 3), or 4+ hours/day (OR = 0.07, 95% CI = 0.01; 0.47,  $p < .01$ ; Table 3) had lower odds of sleeping 9–11 hours. With

each one day increase of physical activity per week, the odds of sleeping 9–11 hours increased by 29% (OR = 1.29, 95% CI = 1.03, 1.61,  $p < .05$ ; Table 3). For sleep duration measured continuously, children who spent 4+ or 2–3 h/day on media use slept less than those who spent 0–<1 hours/day (~10 hours 8 minutes, ~10 hours and 16 minutes, ~10 hours 31 minutes; Table 4).

### Sensitivity analyses

**Recommended hours of sleep as 9–12 hours**—The National Sleep Foundation recommends that 7–8 or 12 hours of sleep “may be appropriate” for school-aged children.<sup>18</sup> As such, we examined sleep duration using 9–12-hour categories ( $n = 1176$ ) versus less-than-9-hour ( $n = 149$ ) categories, and excluded children with more than 12 h of sleep ( $n = 7$ , Table 5). The results of the sensitivity analysis were similar to the analysis of sleeping within the 9–11 hours range (Table 3) with the exception of the adult health variable in the Pre-K-5th grade sample, which was significant at  $p < .05$  for the 9–11 hours range (OR = 3.45, 95% CI 1.06, 11.22,  $p < .05$ , Table 3), but was not significant for the 9–12 hours range (OR = 3.16, 95% CI 0.99, 10.05, Table 5). However, because the odds ratios and confidence intervals are similar between the 9–11 hours and 9–12 hours range, the difference in significance could be attributed to the sample size included in each group.

### Exclusion of pre-k

It is possible that napping behaviors among the Pre-K children may represent a meaningful subsample in the data. To test this possibility, we re-ran all of the analyses excluding the Pre-K youth (Table 3–5). For the logistic regressions (probability of sleeping 9–11 hours and 9–12 hours), the results were similar with no significant differences in the coefficients or confidence intervals. However, the association between physical activity and the probability of sleeping 9–12 hours, was no longer significant after excluding the Pre-K children (Table 5). For multivariable regression analysis predicting sleep duration in hours, differences were observed for having a smoker in the home and the child’s health history. After excluding the Pre-K children, living with a smoker was associated with longer sleep duration (1st-8th grade:  $b = 0.20$ , SE = 0.09,  $p < .05$ ; 1st-5th grade:  $b = 0.21$ , SE = 0.10,  $p < .05$ ; Table 4). Similarly, after removing the Pre-K children, having a poor health history was significantly associated with shorter sleep duration ( $b = 0.18$ , SE = 0.09,  $p < .05$ ; Table 4) among the 1st-5th grade children.

### Sleeping through the night as an exploratory proxy for sleep quality

Although the dataset did not include a valid and reliable indicator of sleep quality, we conducted exploratory analyses and considered sleeping through the night without waking to be a proxy for sleep quality (Table 6). Having a poor health history (6–12 year-olds: OR = 0.31, 95% CI 0.16, 0.62,  $p < .01$ ; Pre-K-5th grade: OR = 0.33, 95% CI 0.16, 0.69,  $p < .01$ ) and having had asthma (6–12 year-olds: OR = 0.29, CI 0.16, 0.54,  $p < .001$ ; Pre-K-5th grade: OR = 0.24, 95% CI 0.13, 0.47,  $p < .001$ ) were significantly associated with being less likely to sleep through the night for both the entire sample and for the younger sample, after controlling for sleep duration in minutes, sociodemographic characteristics, environmental correlates and other covariates.



### Size of the odds ratios

The size of the odds ratios for predicting sleeping 9–11 hours were unusually high for having a bedtime (Table 3). Therefore, we conducted the analyses without any covariates, and the odds ratios were still statistically significant although they were smaller (OR = 4.48, 95% CI = 2.21–9.08). The odds ratios were similar when ethnicity/race was included in the model (OR = 4.76, 95% CI = 2.34–9.70).

## Discussion

Sleep is fundamental to health and well-being. For children and adolescents, adequate sleep duration plays an important role in optimal development<sup>1,2</sup>. Comparing the relative impact of sociodemographic and environmental correlates of childhood sleep duration, the results identified several sociodemographic factors associated with childhood sleep duration, including ethnicity/race, age, having a regular bedtime, attending a private school, physical activity, and media use in a representative and diverse sample of children between ages 6–12 in New York City. While the vast majority of children met the NSF-recommended 9–11 hours of sleep per night, consistent with existing research, ethnic/racial differences in sleep duration were observed in our study<sup>12–14</sup>. Specifically, Asian, Black, and Latino children slept less than White children; a pattern that was observed for the full sample of 6–12-year-olds, as well as the pre-K-5th grade children. There was little evidence that the environmental features under investigation in this study were associated with getting enough sleep.

### Sociodemographic characteristics and sleep duration

First, multivariable logistic regressions investigated whether children were sleeping the recommended 9–11 hours on a typical school night. Younger children in both the full sample and in the pre-K-5th grade subsample were more likely to sleep 9–11 hours. For the pre-K-5th grade children, child's nativity was associated with whether the child slept the NSF recommended 9–11 hours. Consistent with research on adult populations in the United States<sup>7,12</sup>, pre-K through 5th-grade children born in the United States were less likely to get the recommended 9–11 hours of sleep. United States culture may shape abbreviated sleep duration<sup>9</sup> due to the prevailing narrative that Americans are more productive when they sleep less.

In addition to investigating children's sleep with the recommended 9–11 hours, sleep duration in hours was also examined. Sleep duration is of particular importance to childhood development and has been linked to various health outcomes, such as obesity, cognitive functioning, and emotion regulation<sup>31,32</sup>. In particular, sleep has been implicated in children's cognitive functioning and academic achievement<sup>34</sup>. Our findings on sleep duration in hours contribute to childhood sleep research more broadly. For example, the study observed normative age-related declines in sleep duration<sup>29</sup>. Age-related decreases in sleep duration may in part be attributable to structural changes such as earlier school start times, increased academic demands, and increased autonomy<sup>13</sup> as well as biological changes such as puberty<sup>53,54</sup>.

Consistent with research on English children across a similar age span<sup>3</sup>, differences in ethnicity/race-based sleep duration were evident in both the full sample and the pre-K-5th grade subsample (although it is important to recognize that sociocultural dynamics may differ between the United States and the United Kingdom). Another study found that Black children in the United States were more likely to nap and have later bedtimes than their White counterparts, possibly explaining differences in nocturnal sleep patterns<sup>34</sup>. Although sleep is a biological necessity, its expression is grounded in sociocultural contexts<sup>35</sup> and cultural beliefs about the importance of sleep for child development and health, yet these differences remain largely unexplored. The Race-Based Disparities in Stress and Sleep in Context Model (RDSSC) implicates differential exposure to stress as a source of ethnic/racial sleep disparities.<sup>36</sup> Indeed, recent meta-analyses and research have observed effects of discrimination on sleep among adults<sup>37</sup> and adolescents.<sup>38–40</sup> Moreover, a meta-analysis on the health effects of discrimination found that younger children are more affected than older children,<sup>41</sup> possibly explaining the consistent disparities for the younger cohort. While the current study underscores ethnic/racial differences in sleep duration measured in hours, and the study includes several documented correlates of childhood sleep, it is still possible that there are other unmeasured “third” variables (e.g., undiagnosed sleep apnea) that underlie the associations between ethnicity/race and sleep,<sup>42–44</sup> The current findings extend discussions on ethnic/racial differences in sleep beyond Black-White comparisons and call for continuing research to unpack related correlates for these disparities. For example, research on the impact of delaying school start times on adolescent outcomes has found more pronounced effects on improving absences and first-period tardies for predominantly ethnic/racial minority schools,<sup>13</sup> raising the question of whether interventions should consider the demographics of the target population.

In addition, future research should consider how the magnitude of these differences is linked to other known disparities in the domains of health and academic outcomes. The magnitude of observed differences (i.e., 13–23 min shorter sleep duration) is in the range of existing research observing correlates of childhood sleep duration.<sup>25</sup> For example, research on academic outcomes finds that an hour of delayed wake time is associated with a 0.13 increased in first-year college grade point average.<sup>45</sup> Research on media use finds that each hour youth spend on media use is associated with a 3.6-minute decrease in sleep duration.<sup>46</sup> Similarly, having a TV in a child’s bedroom was associated with a 31-minute decline in sleep duration, an effect that was even more pronounced for ethnic/racial minority youth.<sup>25</sup> Unfortunately, it was beyond the scope of this paper to consider how ethnicity/race or SES intersects with sociocultural and environmental predictors of sleep duration, however, existing research has focused on disentangling these related influences.<sup>8–10</sup> Although the analyses did not support the influence of family SES on sleep, the bivariate associations suggested a link between attending a private school and longer sleep duration, an observation consistent with research linking SES to sleep.<sup>10</sup>

Of note, contrary to existing research and our hypotheses, there were no significant associations between either of the SES indicators (family SES, public vs. private school) and getting 9–11 hours of sleep, or sleep measured in minutes. However, a consideration of the bivariate associations in the sample suggest that the SES indicators may share variance with other variables of interest. For example, children attending private schools had longer sleep

duration and private school attendance was higher for Asian and Latino families, and lower among non-US born children and adults. Similarly, family SES is higher among Asian and lower among the Black and Latino families in our sample, and children of two US-born parents also had higher family SES. These bivariate correlations suggest that the SES indicators share significant variance with other sociodemographic indicators, possibly resulting in that lack of significant effects for family SES alone. It is also possible that significant effects observed for child nativity and ethnicity/race could be explained by shared variance between these variables. However, 84–95% of the target youth were born in the United States (unweighted: Asians = 84%, Black = 95%, Latino = 90%, White = 93%; weighted: Asians = 89%, Black = 93%, Latino = 86%, White = 93%). Future research that includes a more diverse sample in terms of nativity may be better at investigating this possibility.

### **Environmental correlates and sleep duration**

Despite research pointing to the importance of neighborhood and environmental conditions on sleep duration,<sup>8,47</sup> there was little evidence for the influence of the two environmental correlates (i.e., crowding, presence of a smoker) under investigation in these analyses. The current measures of environmental factors were proximal and did not extend outside of the target child's home; as such, the shared urban context may have limited variability in environmental correlates. Also, relative to existing research that has found that home conditions account for SES-differences in sleep,<sup>8–10</sup> the current sample relies on adult-respondent reports (as compared to observer or child-reported conditions). On the one hand, it is possible that since adult respondents shared the same home environment as the target child, they may be more accurate reporters of the two relatively objective variables under investigation; it is also possible that they would be less able to provide accurate accounts of their living conditions due to a lack of a comparison frame of reference. Because the current study also considers the relative impact of sociodemographic and environmental correlates of sleep duration in the same model, it is also possible that the observed sociodemographic correlates share significant variance with environmental features (e.g., residential crowding and SES). As such, existing research that points to the importance of environmental correlates may be explained by how contextual features are intertwined with sociodemographic characteristics of children and their families.

### **Covariates and sleep duration**

Having a regular bedtime promoted, while excessive media use (i.e., greater than 4 hours) interfered with, sleeping 9–11 hours. Physical activity was also associated with sleeping 9–11 hours for the full sample and the pre-K-5th grade subsample.<sup>13,48</sup> Because information about children's sleep was provided by adult respondents, this association may reflect the symbiotic association between adult and children who sleep in the same household where parents with poor sleep quality are more likely to report that their children also suffer from poor sleep quality,<sup>49</sup> or it is also possible that associations reflect reporting biases. It is also worth mentioning that the NSF recommendation of 9–11 hours of sleep per night should be interpreted in the context of a more general recommendation of 7–12 hours of sleep as “appropriate.” To address this possibility, sensitivity analyses were conducted and reported; however, the results of this larger window yielded comparable results to the 9–11 hours

recommendation. Sleep scientists have already acknowledged the clinical importance of having a regular bedtime, excessive media use, and physical activity in sleep hygiene interventions.<sup>50</sup> As such, the current research lends further support to focusing on these modifiable behaviors as health levers, and focal areas of intervention.

Covariates related to sleep hygiene such as the importance of having a regular bedtime<sup>19</sup> and physical activity,<sup>48</sup> and the detrimental effects of media use<sup>22</sup> were also evident in analyses investigating sleep duration in hours. The importance of a regular bedtime was present in the entire sample including the pre-K-5th grade children. Although children gain autonomy as they age, to promote sufficient sleep duration, it is important for households to maintain good sleep hygiene and bedtime routines. These data are consistent with the protective effects of family rules and structures, including regular bedtimes for childhood sleep.<sup>13</sup> Echoing existing research,<sup>22</sup> media use was incrementally associated with shorter sleep duration for the full sample.

### Limitations

Results need to be considered with limitations. This sample was large, ethnically/racially diverse, and representative of the New York City population; however, the results may not generalize to other populations. In addition, data were collected in 2009, and cohort effects are possible. Also, the sample included only families with a landline phone, and the response rates were relatively low (27% for the CHS sample frame and 48% for the supplemental RDD sample frame), which limits generalizability. However, the NYC DOHMH evaluated their Community Health Survey data in 2008 and found very few differences in the main health measures comparing the landline survey and the combined landline and cell phone survey.<sup>51</sup> Compared to Pre-K-5th grade, the sample of 6th-8th grade children was smaller, precluding separate analysis for this older age group. Children's sleep was based on adult respondent reports, which may be influenced by adults' own sleep problems.<sup>49</sup> Combining adult and/or child self-reports with objective indicators of sleep actigraphy is becoming increasingly common<sup>10</sup> and the inclusion of each addresses the limitations of the other. For example, adult reports of childhood sleep may have limited accuracy, and this accuracy may even decline as children move through adolescence and gain more autonomy. Although data on sleep duration across adult reports and actigraphy have been found to be comparable,<sup>52</sup> and actigraphy may be cost-prohibitive, future research should consider including both self-report and actigraphy based measures of sleep. Furthermore, other sleep indicators such as sleep quality and variability provide more nuanced assessments of children's sleep. Of note, the crowding variable was constructed as a ratio of people to rooms in the home, but detailed information about the distribution of people to rooms (and bedrooms in particular) was not available. Future research would benefit from focusing on bedroom crowding as a more proximal influence on sleep. Data on pubertal development were not available in the dataset, precluding investigation of this important developmental process on sleep.<sup>53,54</sup> Finally, adult respondents were queried about sleep on a "typical school night", precluding investigation of known differences in weeknight versus weekend sleep.<sup>13</sup>

## Conclusions

Despite these limitations, the current study evidences the influence of sociodemographic characteristics on child sleep duration, including ethnic/racial differences in sleep duration among a representative sample of New York City households. Sleep health is a gateway to a host of socioemotional, physical, and academic outcomes.<sup>1,2</sup> Sleep duration varied across sociodemographic groups among children in New York City. Future research should continue to investigate the causes and consequences of sociodemographic disparities in childhood sleep and whether these disparities are linked to disparities in health and academic outcomes.

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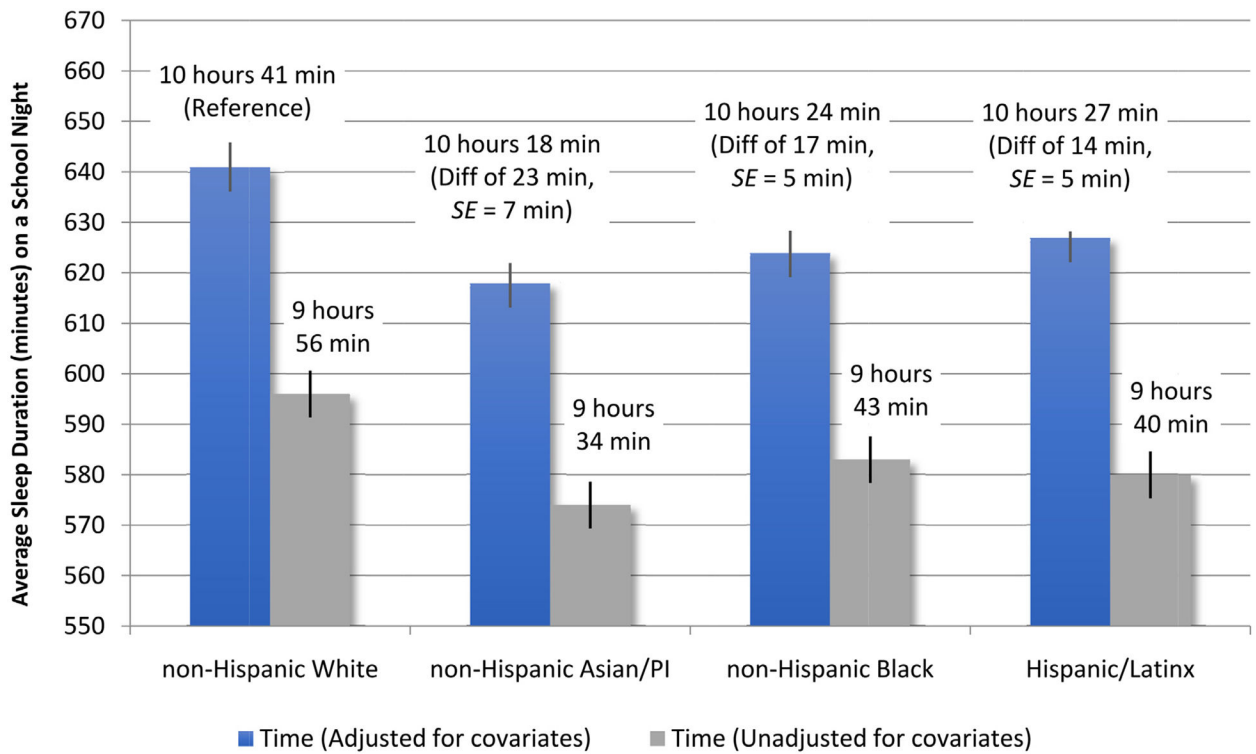
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**Fig. 1.**  
Ethnic/racial differences in sleep duration.

Adjusted and unadjusted sleep duration by ethnic/racial group.

Notes. Models are adjusted for sleeping through the night, having a regular bedtime, physical activity, media use, child health history, asthma, age, gender, child nativity, parent nativity, family SES, crowding, smoker in the home. Non-Hispanic Asian/PI, non-Hispanic Black, and Hispanic/Latino children sleep significantly less than non-Hispanic White children.

Bonferroni post-hoc pairwise comparisons revealed no significant differences between Asian, Black or Latino children (adjusted  $p = 0.05/6$  comparisons = 0.008).

Weighted descriptive statistics of study variables among Pre-K-8th grade school children, 6-12 years old, New York City, 2009<sup>a,b</sup>

**Table 1**

Variable	n (Weighted N)	% [95% CI]	Mean (SD) [95% CI]	Min	Max
Sleep duration (h, minutes)	1285 (617,000)		9 h 44 min (44 min) [9h41 min~9 h 48 min]	6 h 25 min	11 h
White	377 (162,000)	26.15% [22.96-29.34%]	9 h 56 min (46 min)	7 h	11 h
Asian	100 (75,000)	12.22% [9.26-15.18%]	9 h 52 min~10h 1 min	7 h 40 min	11 h
Black	336 (164,000)	26.55% [23.20-29.90%]	9 h 43 min (44 min) [9 h 38 min~9 h 47 min]	6 h 25 min	11 h
Latino	472 (216,000)	35.08% [31.53-38.64%]	9 h 40 min (44 min) [9 h 36 min~9 h 44 min]	7 h 30 min	11 h
Sleep duration (9-11 h)	1136 (616,000)	89.29% [86.90-91.70%]			
Sleep through the night	1176 (620,000)	91.54% [89.59-93.48%]			
Child's age (years)	1279 (613,000)		9.12 (1.96) [9.01~9.22]		
Child's sex/gender (female)	611 (283,000)	45.70% [41.95-49.45%]			
Child - US-born	1183 (557,000)	90.28% [88.14-92.43%]			
Child - foreign-born	109 (60,000)	9.72% [7.57-11.86%]			
Both parent US-born	473 (201,000)	33.2% [29.66-36.74%]			
At least one parent foreign-born	789 (406,000)	66.80% [63.26-70.34%]			
Family SES <sup>c</sup>	1173 (559,000)		3.30 (2.06) [3.18-3.41]	0	7
Highest level of education by anyone in the household					
Less than high school	128 (78,000)	12.77% [10.04-15.49%]			
High school grad	304 (158,000)	25.75% [22.42-29.08%]			
Some college	278 (166,000)	27.01% [23.41-30.62%]			
College grad	574 (212,000)	34.47% [31.06-37.87%]			
Income					
<100%FPL	293 (181,000)	32.41% [28.45-36.37%]			

Variable	n (Weighted N)	% [95% CI]	Mean (SD) [95% CI]	Min	Max
100 to 199%	262 (140,000)	25.10% (21.52–28.67%)			
200 to 399%	238 (106,000)	19.01% (16.07–21.94%)			
400 to 599%	209 (76,000)	13.58% (11.14–16.02%)			
600%+	174 (55,000)	9.90% (8.15–11.65%)			
School type - public	996 (488,000)	78.70% (75.56–81.84%)			
School type - private	297 (132,000)	21.30% (18.16–24.44%)			
Crowding (ratio people: room)	1292 (620,000)		1.08 (0.60) [1.05–1.11]	0.17	6.00
Smoker in the home (yes)	141 (66,000)	10.75% (8.35–13.15%)			
Regular bedtime (yes)	1221 (619,000)	95.28% (93.93–96.62%)			
Media use (0 or < 1 hr)	114 (60,000)	9.88% (7.54–12.23%)			
Media use (1 h)	170 (79,000)	12.89% (10.47–15.31%)			
Media use (2–3 h)	520 (246,000)	40.33% (36.57–44.09%)			
Media use (4 h or more)	473 (225,000)	36.89% (33.23–40.56%)			
Physical activity (days/week)	1288 (617,000)		2.69 (1.86) (2.58–2.79)	0	7
History of health conditions (yes)	214 (99,000)	16.12% (13.43–18.81%)			
History of asthma (yes)	234 (106,000)	17.12% (14.43–19.80%)			
History of early intervention (yes)	345 (169,000)	27.56% (24.15–30.96%)			
Adult health (fair/poor)	213 (117,000)	18.91% (15.81–22.00%)			
Adult health (good)	432 (213,000)	34.45% (30.76–38.15%)			
Adult health (very good)	376 (163,000)	26.32% (23.19–29.45%)			
Adult health (excellent)	269 (126,000)	20.32% (17.31–23.32%)			

<sup>a</sup>The estimates were obtained from Stata/SE 12.1 software. The 95% CI's may be slightly different from those obtained from SUDAAN or other statistical software programs due to differences in estimation methods.<sup>40</sup>

<sup>b</sup>Family SES was calculated by combining the highest level of education completed in the household (0=less than high school, 1=high school grad, 2=some college, 3=college grad) with the annual household income relative to the Federal Poverty Level (0=<100% FPL, 1 = 100 to 199%, 2 = 200 to 399%, 3 = 400 to 599%, 4 = 600%+).

<sup>c</sup>Population estimates were rounded to the nearest thousand.

relation table of study variables

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
.65***	-																		
-																			
-																			
-																			
0.31***	-0.19***	-0.02	-0.03	-0.01	-														
0.01	-0.02	0.04	0.02	-0.07*	0.03	-													
.03	-0.03	-0.02	0.06*	-0.10***	-0.08**	0.01	-												
.03	-0.03	-0.26	0.1***	-0.14***	0.05	0.08**	0.23***	-											
0.00	0.01	0.06*	-0.11***	-0.30***	0.01	-0.01	0.04	0.16***	-										
0.08**	-0.02	0.08**	0.05	0.24***	-0.03	-0.03	-0.10***	-0.15***	-0.29***	-									
.01	-0.04	0.05	-0.09**	0.23***	-0.16***	-0.01	-0.12***	-0.23***	-0.37***	0.16***	-								
0.04	-0.07*	0.08**	0.11***	0.02	0.09**	0.06*	0.04	0.12***	-0.12***	0.10***	-0.04	-							
.03	-0.05	-0.07*	-0.00	0.00	0.04	-0.03	0.03	0	0.03	-0.03	-0.01	-0.06*	-						
.17***	0.15***	0.03	0.03	0.00	0.01	0.03	0.01	-0.04	-0.05	0.00	0.02	-0.06*	0.03	-					
0.22***	-0.10***	-0.01	0.10***	0.10***	0.14***	0.02	-0.06*	-0.02	-0.12***	0.21***	-0.01	0.10***	-0.04	0.02	-				
.08**	0.06*	-0.16***	0.13***	-0.14***	-0.07*	0.05	0.12***	0.19***	0.16***	-0.10***	-0.14***	0.07*	0.04	-0.01	0.01	-			
0.05	-0.03	-0.11***	0.01	0.08**	0.05	0.10***	-0.01	0.02	-0.06*	0.08**	-0.08**	0.15***	-0.11***	-0.01	0.07***	-0.05	-		

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	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0.04	-0.01	-0.03	0.05	0.111***	0.02	0.03	0.06*	0.04	-0.07*	0.10***	-0.06*	0.06*	-0.15***	-0.01	0.04	-0.00	0.12***	-	-
0.02	0.01	-0.07**	0.09**	0.03	-0.01	0.111***	0.02	0	-0.08**	0.06*	-0.03	0.18***	-0.09**	-0.03	0.03	-0.02	0.53***	0.13***	-
0.06*	0.04	-0.03	-0.01	-0.19***	0.04	-0.03	0.05	0.07**	0.30***	-0.116***	-0.18***	-0.09***	0.06*	0.02	-0.02	0.11***	-0.10***	-0.14***	-0.13***

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between 9 and 11 h; **Child ethnicity/race**: 0=White, 1=Asian, 1=Black, 1=Latino; **Child sex/gender**: 0=female, 1=male; **Child nativity**: 0=foreign-born, 1=US-born; **Child nativity**: 0=child has at least one foreign-born parent, 1=US-born; **Family SES**: Combines the highest level of education completed in the household (0=less than high school, 1=high school graduate, 2=college grad) with the annual household income relative to the Federal Poverty Level (0=<100% FPL, 1 = 100 to 199%, 2 = 200 to 399%, 3 = 400 to 599%, 4 = 600%+), 0 = lowest, 3=college grad) with the annual household income relative to the Federal Poverty Level (0=<100% FPL, 1 = 100 to 199%, 2 = 200 to 399%, 3 = 400 to 599%, 4 = 600%+), 0 = lowest, 3=college grad); **Crowding**: Number of people/number of room ratio; **Smoker in home**: 0=none, 1=at least 1 smoker; **Sleep through night**: 0=no, 1=sleep through night of the past 7 days; **Health history**: 0=no, 1=at least 1 diagnosis of health conditions such as ADHD, depression, developmental delays, etc.; **Asthma**: 0=no, 1=has asthma; **Early medical care**: 0=never, 1=at least 1 case of needing or receiving early medical care and/or mental health services intervention; **Adult's health**: 0=fair/poor, 1=good, 2=very good, 3=excellent \*  $p < 0.05$ , \*\*  $p < 0.01$ .



**Table 3**

Logistic regression predicting probability of sleeping 9–11 h

Variables	OR (95% CI)			
	All (Pre-K-8th)	1st-8th	Pre-K-5th	1st-5th
<b>Sociodemographic Characteristics</b>				
Asian (ref: White)	0.59 (0.14–2.48)	0.54 (0.13–2.28)	0.51 (0.08–3.18)	0.48 (0.08–2.88)
Black (ref: White)	0.77 (0.35–1.68)	0.82 (0.38–1.78)	0.56 (0.21–1.53)	0.60 (0.22–1.62)
Latino (ref: White)	0.66 (0.31–1.41)	0.67 (0.32–1.41)	0.64 (0.24–1.67)	0.65 (0.25–1.67)
Child age	0.71 (0.61–0.83)***	0.73 (0.62–0.86)***	0.71 (0.58–0.88)**	0.73 (0.59–0.92)**
Child sex/gender	0.63 (0.33–1.18)	0.61 (0.33–1.15)	0.86 (0.39–1.90)	0.82 (0.37–1.83)
Child nativity	0.40 (0.15–1.08)	0.39 (0.14–1.06)	0.12 (0.02–0.85)*	0.11 (0.02–0.81)*
Parent nativity	0.63 (0.34–1.17)	1.57 (0.84–2.93)	0.57 (0.26–1.25)	1.74 (0.77–3.91)
Family SES	0.93 (0.79–1.08)	0.93 (0.79–1.08)	0.92 (0.74–1.15)	0.92 (0.74–1.15)
School type	1.06 (0.54–2.08)	1.06 (0.54–2.07)	0.72 (0.29–1.80)	0.73 (0.29–1.81)
<b>Environmental Correlates</b>				
Crowding	0.64 (0.30–1.35)	0.62 (0.29–1.33)	0.82 (0.21–3.26)	0.78 (0.19–3.18)
Smoker in the home	1.54 (0.69–3.45)	1.64 (0.72–3.74)	2.46 (0.81–7.43)	2.88 (0.90–9.18)
<b>Covariates</b>				
Sleep through the night	0.45 (0.15–1.38)	0.37 (0.11–1.26)	0.55 (0.15–1.96)	0.43 (0.10–1.80)
Bedtime	8.06 (3.42–19.02)***	7.18 (3.05–16.87)***	8.26 (2.53–28.91)***	6.81 (2.12–21.95)**
Media use (1 hr; ref: 0 or < 1 hr)	0.24 (0.05–1.19)	0.25 (0.05–1.22)	0.10 (0.01–0.82)*	0.11 (0.01–0.81)*
Media use (2–3 h)	0.27 (0.06–1.24)	0.29 (0.06–1.29)	0.11 (0.01–0.78)*	0.11 (0.02–0.79)*
Media use (4 h or more)	0.14 (0.03–0.64)*	0.14 (0.03–0.62)*	0.07 (0.01–0.47)**	0.06 (0.01–0.43)**
Physical activity	1.22 (1.03–1.45)*	1.21 (1.02–1.43)*	1.29 (1.03–1.61)*	1.27 (1.01–1.59)*
Health history	0.95 (0.43–2.12)	1.06 (0.47–2.39)	0.52 (0.19–1.43)	0.60 (0.21–1.68)
Asthma	0.78 (0.38–1.58)	0.72 (0.35–1.47)	0.71 (0.28–1.83)	0.63 (0.24–1.64)
Early intervention	1.63 (0.80–3.30)	1.56 (0.77–3.15)	2.53 (0.98–6.53)	2.35 (0.91–6.06)
Adult health (fair/poor; ref: excellent)	0.69 (0.23–2.03)	0.66 (0.23–1.89)	0.88 (0.25–3.05)	0.81 (0.24–2.72)
Adult health (good)	2.06 (0.82–5.18)	2.12 (0.86–5.27)	4.28 (1.42–12.84)***	4.45 (1.50–13.14)**
Adult health (very good)	1.87 (0.73–4.81)	1.83 (0.72–4.62)	3.45 (1.06–11.22)*	3.24 (1.02–10.30)*
# of observations	1101	1037	858	794

Notes.

\*  $p < 0.05$ .

.1000 >  $p$   
\*\*\*  
.101 <  $p$   
\*\*

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**Table 4**

Linear regression predicting sleep duration in hours

Variables	B(SE)			
	All (Pre-K-8th)	All (1st-8th)	Pre-K-5th	1st-5th
Intercept	10.68 (0.30)***	10.75 (0.32)***	10.52 (0.34)***	10.58 (0.37)***
Sociodemographic Characteristics				
Asian (ref: White)	-0.38 (0.12)**	-0.41 (0.12)**	-0.39 (0.13)**	-0.43 (0.13)**
Black (ref: White)	-0.28 (0.08)***	-0.29 (0.08)***	-0.30 (0.08)***	-0.32 (0.08)***
Latino (ref: White)	-0.24 (0.08)**	-0.26 (0.08)**	-0.21 (0.08)**	-0.23 (0.08)**
Child age	-0.12 (0.01)***	-0.12 (0.02)***	-0.09 (0.02)***	-0.09 (0.02)***
Child sex/gender	-0.03 (0.06)	-0.05 (0.06)	-0.01 (0.06)	-0.03 (0.06)
Child nativity	-0.08 (0.09)	-0.09 (0.09)	-0.08 (0.09)	-0.10 (0.09)
Parent nativity	0.01 (0.06)	-0.00 (0.07)	-0.01 (0.07)	0.02 (0.07)
Family SES	-0.03 (0.02)	-0.03 (0.02)	-0.02 (0.02)	-0.02 (0.02)
School type	-0.02 (0.07)	-0.02 (0.07)	-0.06 (0.07)	-0.06 (0.07)
Environmental Correlates				
Crowding	-0.05 (0.07)	-0.02 (0.08)	0.00 (0.08)	0.04 (0.09)
Smoker in the home	0.14 (0.09)	0.20 (0.09)*	0.13 (0.10)	0.21 (0.10)*
Covariates				
Sleep through the night	0.06 (0.07)	0.02 (0.07)	0.05 (0.08)	0.01 (0.08)
Regular bedtime	0.68 (0.17)***	0.65 (0.17)***	0.57 (0.19)**	0.52 (0.19)**
Media use (1 hr; ref: 0 or < 1 hr)	-0.10 (0.12)	-0.08 (0.12)	-0.10 (0.12)	-0.08 (0.12)
Media use (2-3 h)	-0.23 (0.10)*	-0.23 (0.10)*	-0.25 (0.11)*	-0.26 (0.11)*
Media use (4 h or more)	-0.39 (0.10)***	-0.38 (0.11)***	-0.38 (0.11)***	-0.38 (0.11)**
Physical activity	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)	0.02 (0.02)
Health history	-0.07 (0.09)	-0.08 (0.09)	-0.16 (0.09)	-0.18 (0.09)*
Asthma	-0.08 (0.07)	-0.06 (0.07)	-0.10 (0.08)	-0.09 (0.08)
Early intervention	0.05 (0.07)	0.08 (0.07)	0.05 (0.07)	0.07 (0.07)
Adult health (fair/poor; ref: excellent)	-0.05 (0.12)	-0.06 (0.12)	0.01 (0.13)	0.01 (0.13)
Adult health (good)	0.11 (0.09)	0.11 (0.09)	0.15 (0.09)	0.16 (0.09)
Adult health (very good)	0.12 (0.09)	0.12 (0.09)	0.21 (0.09)*	0.20 (0.10)*
# of observations	1101	1037	858	794

Variables	All (Pre-K-8th)	All (1st-8th)	Pre-K-5th	1st-5th
R-squared	0.22	0.21	0.19	0.19

Notes:

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .

\*\*\*  $p < 0.001$ .

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**Table 5**  
Sensitivity analysis 1: Logistic regression predicting probability of sleeping 9–12 h

Variables	OR (95% CI)				
	All (Pre-K-8th)	All (1st-8th)	Pre-K-5th	1st-5th	
<b>Sociodemographic Characteristics</b>					
Asian (ref: White)	0.54 (0.14–2.16)	0.50 (0.13–1.97)	0.50 (0.08–3.08)	0.47 (0.08–2.78)	
Black (ref: White)	0.83 (0.39–1.76)	0.87 (0.41–1.85)	0.61 (0.23–1.61)	0.65 (0.25–1.71)	
Latino (ref: White)	0.69 (0.33–1.44)	0.69 (0.33–1.43)	0.63 (0.25–1.62)	0.64 (0.25–1.61)	
Child age	0.71 (0.61–0.82)***	0.72 (0.62–0.85)***	0.71 (0.58–0.87)**	0.73 (0.59–0.92)**	
Child sex/gender	0.66 (0.36–1.23)	0.65 (0.35–1.21)	0.90 (0.41–1.98)	0.87 (0.39–1.92)	
Child nativity	0.43 (0.16–1.14)	0.42 (0.16–1.11)	0.12 (0.02–0.88)*	0.12 (0.02–1.83)*	
Parent nativity	0.58 (0.32–1.07)	0.59 (0.32–1.08)	0.54 (0.25–1.17)	0.55 (0.25–1.20)	
Family SES	0.93 (0.80–1.08)	0.92 (0.79–1.07)	0.93 (0.75–1.15)	0.93 (0.75–1.15)	
School type	1.10 (0.57–2.12)	1.10 (0.58–2.10)	0.67 (0.27–1.67)	0.68 (0.28–1.68)	
<b>Environmental Correlates</b>					
Crowding	0.62 (0.30–1.30)	0.61 (0.29–1.28)	0.84 (0.21–3.34)	0.80 (0.20–3.25)	
Smoker in the home	1.20 (0.55–2.60)	1.27 (0.58–2.80)	2.06 (0.70–6.05)	2.36 (0.77–7.25)	
<b>Covariates</b>					
Sleep through the night	0.35 (0.11–1.15)	0.29 (0.08–1.04)	0.51 (0.14–1.84)	0.40 (0.09–1.69)	
Bedtime	7.05 (2.98–16.71)***	6.36 (2.70–14.96)***	8.17 (2.51–26.58)***	6.77 (2.11–21.74)**	
Media use (1 hr; ref: 0 or < 1 hr)	0.26 (0.05–1.28)	0.27 (0.05–1.32)	0.11 (0.01–0.80)*	0.11 (0.02–0.82)*	
Media use (2–3 h)	0.24 (0.05–1.08)	0.26 (0.06–1.13)	0.10 (0.01–0.80)*	0.11 (0.02–0.71)*	
Media use (4 h or more)	0.13 (0.03–0.60)**	0.13 (0.03–0.58)**	0.06 (0.01–0.44)**	0.06 (0.01–0.42)**	
Physical activity	1.21 (1.02–1.42)*	1.19 (1.01–1.41)*	1.27 (1.02–1.59)*	1.25 (1.00–1.57)	
Health history	0.96 (0.44–2.12)	1.07 (0.48–2.38)	0.53 (0.19–1.46)	0.61 (0.22–1.71)	
Asthma	0.74 (0.37–1.48)	0.68 (0.34–1.37)	0.64 (0.26–1.60)	0.57 (0.23–1.44)	
Early intervention	1.62 (0.80–3.29)	1.56 (0.77–3.16)	2.55 (0.98–6.61)	2.36 (0.91–6.12)	
Adult health (fair/poor; ref: excellent)	0.67 (0.23–1.97)	0.65 (0.23–1.83)	0.86 (0.25–3.02)	0.80 (0.24–2.70)	
Adult health (good)	1.94 (0.78–4.84)	2.00 (0.81–4.92) (1.02–5.52)	4.20 (1.41–12.58)*	4.36 (1.48–12.84)**	
Adult health (very good)	1.83 (0.72–4.61)	1.79 (0.72–4.44)	3.16 (0.99–10.05)	2.96 (0.95–9.22)	
# of observations	1144	1074	895	825	

Notes.

\*  $P < 0.05$ .

.1000 >  $p$   
\*\*\*  
.101 <  $p$   
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**Table 6** Sensitivity analysis 2: Logistic regression predicting sleep quality (probability of sleeping through night without waking)

Variables	OR (95% CI)	
	All	Pre-K-5th
<b>Sociodemographic Characteristics</b>		
Asian (ref: White)	0.56 (0.21–1.47)	0.54 (0.18–1.61)
Black (ref: White)	1.08 (0.49–2.37)	1.02 (0.43–2.41)
Latino (ref: White)	1.70 (0.77–3.72)	1.55 (0.65–3.70)
Child age	1.13 (0.99–1.29)	1.05 (0.87–1.26)
Child sex/gender	0.82 (0.46–1.47)	0.77 (0.40–1.47)
Child nativity	1.36 (0.55–3.38)	1.22 (0.43–3.44)
Parent nativity	1.04 (0.57–1.91)	1.20 (0.60–2.38)
Family SES	1.07 (0.89–1.28)	1.07 (0.87–1.30)
School type	1.16 (0.59–2.28)	1.22 (0.60–2.49)
Crowding	1.08 (0.57–2.05)	0.93 (0.49–1.77)
Smoker in the home	0.51 (0.25–1.02)	0.70 (0.32–1.53)
<b>Covariates</b>		
Sleep duration in minutes	1.14 (0.83–1.57)	1.18 (0.80–1.74)
Bedtime	0.86 (0.32–2.34)	0.52 (0.17–1.58)
Media use (1 hr; ref: 0 or < 1 hr)	1.62 (0.50–5.26)	1.88 (0.50–7.01)
Media use (2–3 h)	1.23 (0.46–3.30)	1.30 (0.46–3.70)
Media use (4 h or more)	1.32 (0.72–2.41)	1.31 (0.68–2.50)
Physical activity	1.07 (0.93–1.24)	1.07 (0.92–1.25)
Health history	0.31 (0.16–0.62)**	0.33 (0.16–0.69)**
Asthma	0.29 (0.16–0.54)***	0.24 (0.13–0.47)***
Early intervention	1.27 (0.66–2.43)	1.12 (0.55–2.26)
Adult health (fair/poor; ref: excellent)	0.96 (0.38–2.43)	1.05 (0.37–2.96)
Adult health (good)	0.87 (0.39–1.96)	0.90 (0.36–2.26)
Adult health (very good)	0.97 (0.42–2.26)	0.85 (0.33–2.16)
# of observations	1101	858

Notes.

\*  $p < 0.05$ .

.1000 >  $p$   
\*\*\*  
.101 <  $p$   
\*\*

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