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Racial/ethnic sleep disparities in US school-aged children and adolescents: a review of the literature

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Abstract

Sleep is essential for optimal health, well-being, and cognitive functioning, and yet nationwide, youth are not obtaining consistent, adequate, or high-quality sleep. In fact, more than two-thirds of US adolescents are sleeping less than 8 hours nightly on school nights. Racial and ethnic minority children and adolescents are at an increased risk of having shorter sleep duration and poorer sleep quality than their white peers. In this review, we critically examined and compared results from 23 studies that have investigated racial/ethnic sleep disparities in American school-aged children and adolescents ages 6–19 years. We found that White youth generally had more sufficient sleep than minority youth, Hispanics had more than Blacks, and there was inconclusive evidence for Asians and other minorities. Recommendations for researchers include the following: (1) explore underlying causes of the disparities of these subpopulations, with a particular interest in identifying modifiable causes; (2) examine factors that may be impacted by racial/ethnic sleep disparities; (3) use a multidimensional approach to measuring sleep disparities; and (4) examine how beliefs about sleep are patterned by race/ethnicity. Understanding sleep disparities can inform interventions, policies, and educational programs to minimize sleep disparities and their impact on health, psychological, and educational outcomes.

Keywords

Adolescents; Children; Disparities; Ethnicity; Race; Sleep

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Introduction

Sleep is essential for optimal health, well-being, and cognitive functioning, and yet nationwide, youth are not obtaining consistent, adequate, or high-quality sleep.[1,2] A consensus statement on sleep time recommendations issued by the National Sleep Foundation advises that school-aged children (6–13 years) receive 9–11 hours, teenagers (14–17 years) receive 8–10 hours, and young adults (18–25 years) receive 7–9 hours of sleep nightly.[3] The Foundation also recommends obtaining high-quality sleep, which is indicated by falling asleep quickly, sleeping through the night, having high sleep efficiency, and taking fewer naps during the day.[4] However, youth are not meeting these guidelines, as more than two-thirds of US adolescents sleep fewer than 8 hours nightly on school nights.[5]

Insufficient sleep can lead to a host of adverse health, psychological, and educational outcomes. Although most documented health outcomes associated with inadequate sleep have been established primarily in adult populations,[6] the evidence among pediatric populations is growing. In a nationally-representative longitudinal study, children and adolescents 3 to 18 years with shorter sleep durations, later bedtimes, or earlier wake times at baseline were more likely to be overweight and have higher body mass indexes at 5-year followup.[7] Additionally, poor sleep can impair cognitive functioning and emotional regulation,[8–11] as a cross-sectional study of children 7 to 11 years showed that longer actigraphy-measured habitual sleep duration was associated with improved academic performance, IQ, and reasoning skills.[12] Furthermore, youth experience a number of biological and social changes that prime them for sleep insufficiency including early school start times,[13–15] circadian phase delay,[16] bedtime autonomy,[17] academic pressures,[18] part-time jobs,[19] and technology[20,21] and caffeine use.[21] The importance of combatting these challenges that youth face to obtaining adequate sleep has gained recent widespread recognition, evident in Healthy People 2020's objective to increase the proportion of adolescents that obtain sufficient sleep.[22]

Sociodemographic characteristics such as race/ethnicity may also influence sleep behaviors and patterns.[23] Race and ethnicity are social constructs that encompass social groupings based on societal and cultural values, beliefs, norms, and practices, where the latter term's main purpose is to discern the groupings of the former, such as "Hispanic white" vs "non-Hispanic white."[24] In this review, we operationalize the term *race/ethnicity* to refer to these socially constructed groupings and subgroupings. One's racial/ethnic identification can impact sleep habits and patterns and even influence physiological processes, which in turn can also disrupt sleep.[23] In adults, Blacks are more likely than Whites to report short[25,26] or long sleep duration,[27,28] which are both risk factors for increased morbidity and mortality.[27,28] Additionally, Black adults are more likely to have poorer self-reported sleep quality and greater daytime sleepiness than Whites.[26]

Several reviews and meta-analyses have documented sleep disparities by race/ethnicity in the general and/or adult population.[27,29–34] Emerging literature has also explored childhood and adolescent sleeping patterns, but how these differ by race/ethnicity has not been well examined,[35,36] as most sleep studies in this age group tend to feature small and homogeneous study samples, focusing primarily on Whites.[37] No reviews to date have

focused their attention exclusively on racial/ethnic disparities in sleep patterns among US children and/or adolescents, or how different methodological considerations may impact findings of racial/ethnic sleep disparities in this population.

This review builds on previous literature by critically reviewing previous studies that have examined racial/ethnic sleep disparities in school-aged children and adolescents in the United States. The purpose of this review was to (1) critically examine and summarize existing studies that have investigated racial/ethnic differences in a variety of sleep outcomes in US school-aged children and adolescents ages 6–19 years old, (2) explore how racial/ethnic sleep disparities may differ by study methodology, and (3) identify impactful areas for future research.

Methods

On June 5, 2017, four databases (PubMed, Web of Science, Embase, and PsycInfo) were searched with the phrase “sleep and (children or adolescents or young adults) and (race or ethnic groups or ethnicity) and (duration or bedtime or wake time or sleep wake problems or sleep problems or sleepiness or efficiency or variability or onset or activity or sleep onset latency or inadequate sleep or sleep disturbance or insomnia or hypersomnia or quality or fragmentation).” No start date filter was used, and the search yielded 1943 records (Fig. 1). Additional articles were located through searching Google Scholar and hand-searching references from other articles. Articles were deemed eligible if they met the following inclusion criteria: (1) study examined sleep disparities as one of its primary objectives; (2) study was a peer-reviewed publication; (3) study was written in English; (4) study sample was from the United States; (5) results included descriptive data on racial/ethnic disparities in one or more sleep outcomes; and (6) majority or all of the study sample was within the age range of 6–19 years, or the study separated results by age group. Figure 1 describes the article screening process. We identified 23 studies included in this review (Table 1).

This review conceptualizes sleep disparities as discrepancies between races/ethnicities in a variety of sleep dimensions, with a special focus on sleep duration, sleep/wake problems (including insomnia symptoms and inadequate sleep), and bedtime/sleep onset. Additionally, this review defines the term *minority* as all races/ethnicities other than White. We critically analyzed and synthesized studies assessing sleep disparities in US school-aged children and adolescents. Three of the authors (DG, JG, JC) independently reviewed all of the articles included for completion of Tables 1, 2, and A1, which compared findings by study methodology, including sleep variables measured, age of participants, instruments used for data collection, and whether studies examined covariates. Any inconsistencies in interpretation of findings were discussed and resolved.

Results

Table 1 summarizes characteristics of the 23 studies that assessed sleep disparities across race/ethnicity in American children and adolescents. Studies included both local and national samples of children and adolescents, with the majority of the local studies stemming from southern US regions. Study designs were mainly cross-sectional (87%), and

several were prospective cohort (13%). Study sizes ranged from 60 to 272,077 participants, most had approximately equal proportions of males and females, and were racially/ethnically diverse. Roughly half of studies examined a single sleep outcome (52%), and the other half (48%) examined more than one sleep outcome. Sleep duration was the most commonly measured outcome (78%), followed by sleep/wake problems (30%) and then bedtime/sleep onset (22%). Other outcomes examined were wake time, daytime sleepiness, efficiency, night-to-night variability (in duration, bedtime, sleep onset, and wake time), quality, and fragmentation. Instruments and data sources used to measure sleep outcomes varied widely (Table 2).

Overall, every study found racial/ethnic disparities for at least 1 sleep outcome. Studies frequently used Whites as a reference group and found that this population had better or more sleep than minorities. There were fewer studies examining differences in sleep across 2 or more minority groups, but several studies indicated that Blacks had worse sleep than Hispanics. There were very limited data on Asians to be able to compare their sleep with other races/ethnicities.

Among the 18 studies that measured duration, 17 (94%) found at least 1 racial/ethnic disparity.[1,2,22,36–49] Overall, Whites had longer duration than Blacks and Hispanics. On average, Black youth tended to sleep shorter in duration and have later bedtimes than Hispanics. The few studies involving Asians had mixed results, but data revealed that they slept shorter than Whites and longer than Blacks and Hispanics.

Of the 8 studies that measured sleep/wake problems, 6 (75%) found at least 1 racial/ethnic disparity.[1,46,50–53] In general, White adolescents reported more frequent sleep/wake problems than minorities. There were minimal studies comparing sleep/wake problems between minorities. All 5 of the studies that measured bedtime found at least 1 disparity.[22,44,45,49,54] Minorities had later bedtimes than Whites in 4 studies,[22,44,49,54] and the fifth found that, after completing a program that promoted physical activity, Latina and Black girls (10–14 years) had comparable sleep duration, sleep onset times, and wake times.[45] No studies found disparities in bedtime between minorities.

Age

Three studies included children only (6–13 years) in their sample (13%),[22,48,49] 10 studies included adolescents only (14–19 years) (43%),[1,38–43,51,54,55] and 10 studies included children and adolescents (43%).[2,36,37,44–47,50,52,53] Racial/ethnic sleep disparities were similar for children and adolescents. For both age groups, Whites tended to sleep longer than minorities, Hispanics slept longer than Blacks, and findings were largely inconclusive for Asians. Because of the lack of stratification of results by age group for most studies, it was not feasible to draw definitive conclusions about racial/ethnic disparities by age group.

One notable pattern, however, was that regardless of race/ethnicity, sleep tended to remain the same or worsen as age increased. One study reported on within-group sleep disparities by age, noting that older children and adolescents of every race/ethnicity had shorter parent-reported sleep than those of younger age groups.[37] In this cross-sectional study of 6- to-17-year-olds, parent-reported sleep insufficiency increased for children of every race/ethnicity

(White, Black, Hispanic, and "other" race/ethnicity) for older age groups.[37] For 6- to 9-year-olds, White (29.8%), Black (29.4%), Hispanic (26.0%), and "other" (26.4%) parents reported their child to have sleep insufficiency. For 10- to 13-year-olds, White (37.5%), Black (33.3%), Hispanic (30.9%), and "other" (32.1%) parents reported insufficiency. For 14- to 17-year-olds, White (49.1%), Black (39.3%), Hispanic (35.7%), and "other" (45.9%) parents reported insufficiency.[37] The nature of the disparities did not differ substantially between age groups, with Whites having the highest prevalence of sleep insufficiency, but the actual proportions of children with parent-reported sleep insufficiency increased substantially for children of every race/ethnicity with age.

Additionally, a 5-year prospective cohort study involving White and Hispanic children (median 8.8 years) found disparities in weekday ($P < .0001$) and weekend ($P = .003$) sleep duration at baseline but not at 5-year follow up (weekday: $P = .13$; weekend: $P = .243$).[22] The authors noted that Hispanics did not increase their sleep duration to match that of Whites; instead, Whites slept shorter to match that of Hispanics.[22]

Furthermore, a study comparing children (ages 5–11 years) and adolescents (ages 12–19 years) found that in a nationally representative, racially/ethnically diverse sample, Asian children slept 0.68 hour less than Whites on weekdays ($P < .01$) and Hispanics slept 0.39 hour less than Whites on weekends ($P < .05$); Black adolescents slept fewer hours than White adolescents on both days (weekday: 0.42-hour difference, $P < .01$; weekend: 0.47-hour difference, $P < .05$).[44]

Sleep measures

Seventeen of 23 studies (74%) used self-reports (includes diaries and questionnaires) only,[1,2,22,36–40,44,46,47,49–54] 4 of 23 used objective instruments (ie, polysomnography [PSG] or actigraphy) only (17%),[42,43,45,55] and 2 studies used both (9%).[41,48] Among studies that used self-reports, the most common measure was child-completed questionnaire (10 studies),[1,36,38–41,46,50–52] followed by parent-completed questionnaire (5 studies),[2,22,37,48,53] child-completed time diary (4 studies),[41,44,49,54] and parent-completed time diary (3 studies).[44,47,48] Of the studies that used any self-reported measures, 16 studies used a single self-reported measure,[1,2,22,36–40,46,47,49–54] whereas 3 studies used multiple.[41,44,48] The length of using time diaries varied by study; 3 studies recorded 2 nights (1 school day and 1 nonschool day),[44,47,54] 2 studies recorded 1 week,[41,49] and 1 study recorded 1 night.[48] Among studies that used objective instruments, 4 used actigraphy[41–43,45] and 2 used PSG.[48,55] Among those that used both objective instruments and self-reported data, one used PSG combined with parent-completed time diaries and questionnaires,[48] whereas another used actigraphy combined with child-completed time diaries and questionnaires.[41]

Studies that used self-reported data yielded inconsistent findings, but most studies noted that Whites had the longest sleep of any race/ethnicity. This was found for Whites compared with Blacks,[36,38,40,41,47] Whites compared with Hispanics,[22,36,48] and Whites compared with minorities as a whole.[1,44,49] However, there were some notable exceptions to this trend, as one study found that in nearly all time periods (1991–2012), Black, Hispanic, Asian, and "other" race/ethnicity adolescents (8th–12th grade) were less likely to have 7 or more average hours of sleep than White adolescents (odds ratio [OR]: 1.07; 95% confidence

interval [CI]: 1.02–1.12); yet, in the same time period, Blacks and Hispanics were more likely than Whites to report regular perceived adequate sleep of any race/ethnicity (Black: $P = .03$; Hispanic: $P < .01$).[1] Several other studies found that Whites had poorer sleep than minorities. Two studies found that parents of White children and adolescents (6–17 years) more frequently reported inadequate sleep (parent perceived) in their children than parents of minorities.[37,53] Additionally, it was found that Hispanic children (0–18 years) slept longer than White children by 19 minutes after 9 years of age.[47]

Other studies using self-reported data found that minorities had better sleep than Whites. Specifically, Hispanic children (11–19 years) reported longer duration (9.04 hours vs 6.86 hours) than non-Hispanics ($P < .001$),[46] and White children (11–17 years) had the most trouble initiating sleep compared with Blacks, Hispanics, and "other" race/ethnicity children ($P < .05$).[52] In all time periods from 2003 to 2012 of a cross-sectional study, having inadequate sleep (parent perceived) >3 days per week increased significantly in White children and "other"/mixed race/ethnicity children (6–17 years) ($P < .05$).[2] Lastly, the prevalence of *optimal sleep* (defined as >9 hours) was higher for Hispanic than White adolescents (9th- to 12th-grade students) ($P < .05$; 95% CI: 5.7–7.3).[39] Studies that measured bedtime using self-reported data consistently noted that Whites went to sleep earlier than minorities.[22,44,49,54]

There were limited studies using self-reported data to measure racial/ethnic sleep disparities between minorities, but findings generally followed previously seen patterns of Hispanics having better and longer sleep than Blacks. In a sample of 9th- to 12th-grade students, Black adolescents reported receiving 8 hours of sleep nightly less frequently than Hispanics (21% vs 24%, $P < .05$; 95% CI: 18.8–22.6) and reported receiving <7 hours of sleep nightly more frequently than Hispanics (71% vs 66%, $P < .05$; 95% CI: 61.3–69.6).[39] Black adolescents (13–18 years) also slept shorter than Hispanics (7.54 hours vs 7.72 hours; $P < .001$) in another study.[40] In another study of 11- to 14-year-olds, Hispanic male children (7.95 hours) slept less than Asians (8.51 hours) ($P = .031$).[36]

Findings were also inconsistent between studies that used objective instruments including PSG and actigraphy. Both studies that used PSG found no significant objectively measured racial/ethnic disparities between Whites and Hispanic children (ages 6–11 years)[48] or between White, Black, Hispanic, and Asian adolescents (mean 14.8 years).[55] On the other hand, among the 4 studies that used actigraphy, all found at least some racial/ethnic disparities and noted consistently that minorities slept shorter than Whites. Specifically, actigraphy-measured duration was shorter for Black adolescents (14–19 years) than Whites, regardless of stratification by sex (Black males 6.2 hours, Black females 6.3 hours; white males 6.4 hours, White females 6.9 hours; $P < .05$).[41] Minority children also slept less than nonminority children (13–16 years) by an average of approximately 20 minutes nightly (464 vs 484 minutes; $P < .05$).[42] Among minorities, Blacks consistently slept shorter than Hispanics. In a prospective cohort study of Black and Hispanic girls (10–14 years), baseline data showed that Blacks slept shorter than Hispanics (518 vs 564 minutes; $P = .006$) and had later sleep onset times (12:29 AM vs 11:38 PM; $P = .016$). Following an intervention that promoted physical activity, the 2 groups had comparable sleep duration and sleep onset

times.[45] It was also found that Hispanic children slept 0.2 hour per day more than Black children ($P < .001$).[43]

The 2 studies that used both objective instruments and self-reported or parent-reported data both compared Whites to minorities (Blacks or Hispanics, depending on the study). These studies were uniquely able to compare how disparities differed by measures used and detect potential discrepancies in findings. One study of 6- to 11-year old White and Hispanic children found that although there were no disparities in PSG-measured duration, parents of Hispanic children reported their child sleeping 21 minutes less than White children nightly (587 vs 566 minutes; $P < .0001$).[48] For sleep onset latency, neither PSG nor parent-reported data showed disparities.[48] The other study of 14- to-19-year old White and Black adolescents found that actigraphy-measured sleep duration for the overall week was lower by 0.27 standard deviation for Blacks compared with Whites ($P < .001$) and 0.22 standard deviation lower for weekday sleep duration ($P < .001$); 1-week diary-reported data showed that Blacks reported 0.16 standard deviation fewer hours for the overall week ($P = .01$), and did not show any differences for weekend duration ($P = .33$).[41] Two studies found there to be significant discrepancies in sleep duration measured by objective instruments and diaries. In one study, the estimate of sleep duration (by parent) on any given night was roughly an hour greater than what was measured by PSG,[48] and the other found that the average discrepancy between actigraphy- and diary- (child-completed) measured duration for this study was also roughly an hour for each sex and racial/ethnic (Black vs White) subgroup, with diary data indicating longer sleep times.[41]

Adjustment for covariates

Sixteen studies (70%) adjusted for or stratified by at least 1 covariate,[2,37,39,41–44,46,47,49–55] whereas 7 studies (30%) did not include any covariates.[1,22,36,38,40,45,48] Among those that included covariate(s), 2 studies looked at a single covariate, and 14 studies looked at multiple covariates. The number of covariates that were examined ranged from 0 to 35, with the 3 highest being 35,[44] 21,[2] and 18.[53] There was minimal consistency between studies with what was included as covariates, but the most commonly measured covariates were age, sex, varying measures of socioeconomic status (SES) (eg, parent education, income, and poverty), and neighborhood factors.

Ten of 11 studies (91%) that adjusted for covariates and measured duration found there to be racial/ethnic disparities,[2,37,39,41–44,46,47,49] whereas no disparities in sleep duration were found in a study of ninth-grade students when adjusting for covariates (cov: sex, age, standard of living, generational status, depressive symptoms, alcoholic drinks, and marijuana use).[51]

Results were highly consistent between adjusted and unadjusted analyses regardless of covariates. In a study of 13- to 16-year-olds, crude analyses showed that Whites slept longer than minorities (483 vs 461 minutes, $P < .05$), as did adjusted analyses (cov: sex and vacation status) (484 vs 464 minutes, $P < .05$).[42]

A study of 8- to-11-year-olds also revealed similar findings between adjusted (cov: age, sex, ethnicity, preterm status, chronic health problems, vacation status, and caregiver's education

level) and unadjusted analyses: that older minority boys (10–11 years) had the shortest sleep duration of any sex and race/ethnicity subgroup.[49] In crude analyses of within-group and between-group racial/ethnic differences, minority boys (10–11 years) had the shortest weekend sleep duration (9.25 hours), and when adjusted for age, sex, ethnicity, and vacation, this subgroup also had the shortest sleep duration (9.28 hours) compared with minority girls ($P = .01$),White boys ($P = .02$) and White girls ($P = .005$).[49]

Another study of low-income children (9–12 years) performed adjusted analyses (cov: sex, age, race/ethnicity, obesity status, weekday/weekend, and SES) with and without the inclusion of SES and found that SES had no effect on sleep duration.[43] In the model that included SES, Hispanic children slept 0.2 hour per day more than Black children ($P < .001$); the model without SES showed that Hispanic children slept 0.3 hour per day longer than Black children ($P < .001$).[43]

Results were also consistent between adjusted and unadjusted analyses in a study of children and adolescents (11–19 years).[46] This study, which adjusted for sex, age, grade level in school, and income, found that, in both analyses, Latino adolescents reported longer sleep duration than non-Latinos (unadjusted: mean 9.04 vs 6.83 hours, $P < .001$; adjusted: $\beta = 0.35$).[46]

For adolescents (14–19 years), unadjusted actigraphy results showed that Blacks slept shorter than Whites on all days of the week, and White females had the longest duration of any subgroup when stratified by sex (Black males: 6.2 hours; Black females: 6.3 hours; White males: 6.4 hours; White females: 6.9 hours; $P < .05$).[41] In the adjusted model (cov: smoker, body mass index [BMI], age, physical activity), actigraphy data showed that Blacks slept shorter duration than White students (overall: 0.27 SD; weekday: 0.22 SD; weekend: 0.13 SD).[41] In both models, Blacks also had greater fragmentation in their sleep than Whites.[41]

A study of 6- to-17-year olds also found that Whites were the most likely of any race/ethnicity to report having inadequate sleep, independent of covariates (cov: age, sex, employment, family structure, highest education in household, health care coverage, household poverty, and community/neighborhood safety).[37] In unadjusted analyses, Whites had the highest prevalence of inadequate sleep for each age group compared with Blacks ($P < .05$) and Hispanics ($P < .05$). In the adjusted model, Hispanic (adjusted ORs [aORs]: 0.7–0.8), Black (aORs: 0.76–0.8), and “other”/multiple race children (aORs: 0.7–0.8) were less likely than White children to report inadequate sleep.[37]

However, one study of 6- to-17-year olds showed marked differences in results after adjusting for covariates (cov: 21 covariates representing SES and demographic factors; social, physical, and built environments; and behavioral factors).[2] Unadjusted modes showed that Hispanic and Asian children were more likely to have adequate sleep than White and Black children (<5d/wk of adequate sleep: $P = .040$; <7 d/wk of adequate sleep: $P < .001$).[2] Adjusted models showed minimal disparities for *serious sleep problems* (defined as >3 d/wk of inadequate sleep), but more mild problems in sleeping were more likely for White (29%

higher adjusted odds) and mixed-race children (38% higher adjusted odds), as well as being born to US parents (22%–29% higher adjusted odds).

Additionally, one study of 9th- to 12th-grade students measured the prevalence of sleep disparities by stratifying the sample by race/ethnicity, sex, and grade level.[39] Stratifying by race, the prevalence of receiving >9 hours nightly was highest for Hispanics (11%), 8 hours was highest for Hispanics and Whites (both 24%), and <7 hours was highest for Blacks (71%).[39] Insufficient sleep also increased by grade level, with 10th- (68%), 11th- (75%), and 12th- (78%) grade students having significantly higher prevalence of <7 hours nightly than 9th graders (58%) ($P < .05$; 95% CI: 54.8–60.5); females (71%) were also more likely to sleep <7 hours nightly than males (67%) ($P < .05$; 95% CI: 64.1–69.1).[39]

The study that adjusted for the greatest covariates (cov: 35 demographic, school schedule, activity, and family functioning variables) did not report on differences between crude and adjusted analyses and found that the only consistent disparity in both weekday and weekend sleep duration for adolescents (ages 12–19 years) was that older Black adolescents slept fewer hours than White adolescents (weekday 0.42-hour difference, $P < .01$; weekend 0.47-hour difference, $P < .05$), with no significant within-group differences.[44] Some of the disparity between Blacks and Whites for weekday sleep was accounted for by school travel time (0.59 hour unadjusted vs 0.42 hour adjusted for school travel time).

Lastly, a study of children and adolescents (0–18 years) (cov: age) found that White children generally slept longer than Black children (10- to 15-minute difference depending on age group) and shorter than Hispanic children (19-minute difference for ages 9 and older). However, it should be noted that the authors concluded that there were no clinically significant differences between races/ethnicities, as the discrepancies were deemed too small.[47]

Five of 6 studies that adjusted for covariates and measured sleep/wake problems found disparities.[46,50–53] The study that did not find racial/ethnic disparities between Black and White adolescents (14–19 years) for sleep delay adjusted for smoking, BMI, age, and physical activity.[41] For the other studies, results for unadjusted vs adjusted models were similar. Specifically, a study of 10- to-17-year-olds found that, independent of covariates (cov: age, sex, SES), Mexicans had an approximately 25% increased risk of insomnia often or every day than Whites (OR: 1.28; 95% CI: 1.02–1.61), and Chinese had half the risk of insomnia every day (OR: 0.54; 95% CI: 0.31–0.94).[50] Similarly, a study of 11- to-17-year olds showed that, independent of covariates (cov: age, sex, caregiver education, family income, ethnic identity, ethnic stress), Whites had the greatest difficulty initiating sleep compared with Blacks (aOR: 2.07) and Mexican Americans (aOR: 1.65), and Blacks had a higher frequency of reporting nighttime awakenings (with difficulty returning to sleep) compared with Mexican Americans (aOR: 2.02) and a higher frequency of reporting nighttime awakenings (with return to sleep) than Whites (aOR: 1.52).[52] Another study of 11-to-19-year-olds showed that, independent of covariates (cov: sex, age, grade in school, income), Latinos had a lower prevalence of reporting difficulty staying asleep than non-Latinos ($\beta = -0.33$; $P \leq .010$).[46]

Two studies noted differences in findings for sleep/wake problems between unadjusted and adjusted models.[51,53] The first found that, in unadjusted models, White 6- to-17-year-olds had the highest prevalence of self-reported *inadequate sleep* (defined as not sleeping enough on at least 1 night per week) compared with Blacks, Hispanics, and "other"/multiple race/ethnicity children.[53] In the adjusted model (cov: 18 covariates representing demographics, child health, school and activities, family life), the results were nearly identical, but the Black 6- to 11-year-old subgroup showed a similar prevalence as Whites in reporting inadequate sleep.[53] Finally, a study showed slight differences in the prevalence of insomnia symptoms for a sample of 9th-grade students when adjusting for covariates (cov: sex, age, standard of living, generational status, depressive symptoms, and alcohol and marijuana use).[51] Unadjusted findings revealed that Mexican Americans (Mexico-born) had a lower OR of reporting insomnia symptoms compared with European Americans (OR: 0.68; $P < .05$). Adjusted ORs for self-reported insomnia were not statistically different between European Americans and Mexican Americans (US born), Mexican Americans (Mexico born), and Mexican Nationals.[51]

All studies that adjusted for covariates and examined bedtimes ($n = 3$) found disparities, and specifically, all found that Blacks, Hispanics, and Asian youth had later bedtimes than White youth.[44,49,54] One study that adjusted for 35 variables (demographic, school schedule, activity, and family functioning variables) and stratified by age found that Asian children (5–11 years) had later bedtimes (0.574 hour) than White children and Black adolescents (12–19 years) had later bed times (on average 0.281 hour later) than White adolescents.[44] Similarly, in adjusted regressions (cov: age, day of the week, year, sex, income, and various activities), Black adolescents (15–17 years) had 0.4 hour or approximately 24 to 25 minutes later bed times than Whites ($P = .007$).[54] Another study of children (8–11 years) had similar findings for crude and adjusted analyses when stratifying by sex. In crude analyses, older minority children (10–11 years) had the latest bedtimes (boys: 10:33 PM, girls: 10:37 PM).[49] Similarly, in adjusted regressions (cov: age, sex, ethnicity, and vacation), minority children (8–11 years) were 4.8 times more likely than White children to have a bedtime of 11 PM or later.[49]

Discussion

This is the first review to examine the existing literature on racial/ethnic sleep disparities in US children and adolescents and compare findings among study samples and methodology. As a whole, studies indicated that racial/ethnic minority children and adolescents had shorter sleep duration and worse sleep as measured by a number of parameters, with special emphasis on sleep duration, sleep/wake problems, and bedtime/sleep onset. Whites generally had the best and longest sleep, followed by Hispanics and Blacks, while noting that Asians and other minorities were not greatly represented in the studies included in this review.

The most commonly measured sleep variable was duration (Table A1). Overall, 17 of the 18 studies found a disparity in duration.[1,2,22,36–49] When duration was operationalized as total sleep time measured by PSG or actigraphy, 100% of the studies (5/5) reported significant differences between races/ethnicities.[41–43,45,48] When duration was operationalized by self- or parent-report or diary, 93% of the studies (14/15) found disparities.[1,2,22,36–41,44,46–49] The second most commonly measured aspect was sleep/wake problems or insomnia symptoms:

67% of the studies (6/9) found racial/ethnic disparities.[1,46,50–53] The third most common measure was bedtime/sleep onset, where 100% (5/5) of studies found disparities.[22,44,45,49,54]

Examining the literature by age showed that although racial/ethnic differences were similar for both children and adolescents, every race/ethnicity increasingly struggled to obtain adequate sleep as they aged. Two studies, in particular, most prominently illustrated this trend.[22,37] The pattern of sleep decreasing with age reveals the importance of not only noting the presence of racial/ethnic sleep disparities but assessing the actual amounts of sleep that all races/ethnicities are receiving.

Some studies used multiple sleep measures. Although the majority found that Whites had better sleep than minorities, several studies found that White children and/or adolescents had worse sleep than minorities[37,46,52,53] and that these inconsistencies in disparities differed according to which type of sleep measure was used. Some studies also revealed marked discrepancies between objective variables (eg, duration) and subjective qualities of sleep (eg, perceived adequacy),[1,41] which were more pronounced in racial/ethnic minorities. Thus, the studies that used the strongest methodological approach were those that combined objective sleep instruments (ie, PSG or actigraphy) with self- or parent-reported sleep diaries or questionnaires,[41,48] as they were able to cross-validate data and uncover discrepancies in findings according to sleep measures.

Studies varied in the inclusion of covariates but centered mainly around demographic variables including age, sex, and SES, as well as neighborhood characteristics. Only half of studies that examined covariates indicated that they had a framework for justifying the inclusion of these study covariates.[2,37,42,44,46,49,52,55] Most studies that found racial/ethnic sleep disparities in any of the sleep outcomes yielded similar findings independent of covariates. Only one study had marked differences between adjusted and unadjusted models (cov: 21 covariates representing SES and demographic factors; social, physical, and built environments; and behavioral factors), where adjusting for covariates largely negated any differences found for serious sleep problems.[2] Evidence has previously shown that SES is much more strongly associated with health outcomes than race/ethnicity.[24] The findings from this review, however, demonstrate that SES, a well-known correlate of race/ethnicity, could not account for most the racial/ethnic disparities found, nor did other covariates examined. These findings highlight the critical role that race/ethnicity plays in impacting sleep, regardless of SES and other covariates.

This review reveals at least 4 areas of research in need of attention. First, although it is known that sleep disparities exist, the causal mechanisms of such disparities are largely unknown. Research in racial/ethnic sleep disparities among youth is limited, and findings have been confounded by SES, sex, or both.[36] There is a need to disentangle the role of race/ethnicity from these potential confounding variables and others. Future research using observational data might implement a counterfactual framework to assess any causal effects of race/ethnicity on sleep and the causal effects of any mediators between race/ethnicity and sleep. These may identify points of intervention to reduce sleep disparities.

The identification of significant mediators to inform culturally tailored evidence-based interventions is important because the literature suggests that not all interventions benefit minority races/ethnicities equally, or even at all. For instance, it was found that a school-based intervention only significantly helped White adolescents achieve longer sleep duration and decreased nighttime body movement.[56] The authors speculated that these disparities may be attributed to racial/ethnic disparities in self-efficacy in changing their sleep habits.[56] These findings are consistent with current literature. Although several school-based sleep education programs have been successful in increasing sleep knowledge,[57] sleep duration and efficiency,[58] and academic performance,[58] sleep interventions generally have not led to marked behavior change or improvements in sleep duration or other healthy sleep practices.[35] The lack of success of current interventions in reducing sleep disparities suggests that a more fruitful line of research at present is the identification of the complex explanatory factors of racial/ethnic sleep disparities in children and adolescents that lie "upstream" in the causal chain of sleep disparities.

A second area in need of investigation lies "downstream," that is, whether sleep disparities ultimately lead to disparities in child/adolescent well-being and achievement. Emerging evidence suggests that these associations may exist.[28] Expanding research to include other sleep parameters may be useful, for the literature indicates that there may be aspects beyond duration that impact child/adolescent well-being or achievement.[59] Specifically, sleep efficiency has been found to be a significant predictor of student grades in Italian adolescents,[60] and sleep efficiency, but not sleep duration, was predictive of math and language grades in Canadian children.[61] In recognition of the increasing significance of various aspects of sleep, the National Sleep Foundation (2017) released a consensus statement on age-appropriate levels of sleep efficiency, sleep latency, and nighttime awakenings.[4] Investigating the sequelae of not only sleep duration but also sleep efficiency and other sleep parameters may prove productive.

A third area of research in need of attention is the use of objective sleep instruments to supplement self-reported sleep data. Much of current research may be limited by measurement error due to reliance on self-reports for sleep duration and other sleep variables.[62] Both studies that used objective sleep instruments in combination with self- or parent-reported data showed that estimated sleep duration exceeded objectively measured duration by roughly 1 hour in Whites, Blacks, and Hispanics,[41,48] but there may be systematic biases between minorities and Whites in their self-reported and actual sleep time.[1] Solely using self-reported data may yield biased findings due to minorities potentially overestimating sleep sufficiency.[1] Although not every study in our review that used objective instruments found disparities, the majority did. Additionally, every study that found disparities concluded that Whites fared better than Blacks, Hispanics, and other minorities in sleep duration and efficiency. Findings were discordant for studies using self-reported measures, which may indicate that there are other factors coming into play that would make minorities report receiving better sleep than Whites when objective measures reveal otherwise. Health literacy, particularly in the area of knowledge of standard sleep guidelines, has been hypothesized as an explanatory factor for frequent racial/ethnic variation in self- and parent-reports.[1] White youth and their parents may have greater awareness of how much sleep is recommended for their age group than their minority peers.[1] Compounding this

issue is that certain sleep questionnaires (eg, those asking how many days one's child obtains adequate sleep) rely on the assumption that minority parents are as equally aware of standard sleep guidelines for their child's age as their White peers. These findings underscore the need for more studies to use objective measures and also combine objective with subjective measures to accurately assess both concrete sleep variables as well as perceptions of sleep quality.

Finally, the unknown racial/ethnic validity of these sleep questionnaires points to a need for an investigation of beliefs about sleep. Current literature suggests that cultural norms influence attitudes, sleep behaviors, and nighttime socializing, which can differ between races/ethnicities.[1] Youth of different cultures have a variety of beliefs and practices related to sleep habits,[35] including television or Internet usage habits,[35] bed-sharing, and type of bed they sleep on.[34] Dysfunctional beliefs and inaccurate perceptions about sleep health are also thought to be related to increased sleep anxiety and poorer sleep.[34] However, the impact of differences in cultural practices on sleep is largely unknown,[23] so it is important that beliefs about sleep are explored in greater detail.

There are at several limitations of this review that primarily resulted from the limited literature available for this age range. First, this review was not systematic, and a meta-analysis was not used. Second, studies were compared by whether covariates were adjusted for, but not by the specific covariates adjusted. Third, it was not possible to draw any meaningful conclusions about the sleep health of Asians or other minorities given the low representation in the studies reviewed. Similarly, meaningful conclusions regarding within-group racial/ethnic differences in sleep were not possible because of the limited data available. Although several of the studies analyzed within-group differences by demographic variables (ie, age[22,37,40,44,47,53] and sex[36,38,41,49]), most studies did not. In current literature, there is limited information regarding within-group racial/ethnic differences in sleep, and overemphasis on examining between-group racial/ethnic variation may obscure critical within-group differences.[29] Future studies should seek to incorporate greater sample sizes of Asians and other racial and ethnic populations, as well as consider the within-group variation in sleep, particularly in relation to SES and other demographic variables, as a way to help understand mechanisms underlying differences across racial and ethnic groups.

Fourth, several of the included studies are older and therefore of questionable generalizability to the current generation of children and adolescents. One reason is that new screen media technologies, such as handheld electronic devices, present newer challenges to the sleep of youth, the effects of which have not been captured in older studies. To illustrate, approximately half of the studies (11/23) do not have data after 2007, the year the first iPhone was released. The Kaiser Family Foundation's Generation M2 survey (2010) indicates that mobile technology ownership increased significantly from 2004 to 2009: MP3 player ownership increased from 18% in 2004 to 76% in 2009; cellphones, from 39% to 66%; and laptops, from 12% to 29%.[63] This has been accompanied by increased usage, from an average of 6 hours and 21 minutes in 2004 to 7 hours and 38 minutes, which is “almost the amount of time most adults spend at work each day, except that young people use media seven days a week.”[63] Future research should account for structural and behavioural changes

in adolescent sleep hygiene, habits, and patterns and whether minority sleep has been disproportionately affected.

Finally, although all objectively measured sleep studies ($n = 6$) indicated disparities in total sleep time, these were based on community or regional samples (see Tables 1 and 2: Bates, 2016; Goodwin, 2007; Matthews, 2014; Moore, 2011; Rao, 2009; Wong, 2013).[41–43,45,48,55] There were no studies that analyzed objective sleep data on a nationally representative sample of children or adolescents. This is because such data do not exist, and therefore, there is no accurate estimate of the national prevalence of sleep disparities. Indeed, even a parameter of extraordinary interest such as average total sleep time in the nonadult population is not known with sufficient precision.

In summary, sleep is a modifiable behavior that can impact health,[64] psychological,[36] and educational outcomes,[65] and thus, researching the prevalence of sleep disparities in youth is essential. This review reveals that American school-aged children and adolescents, particularly Blacks and Hispanics, are struggling to obtain sufficient and high-quality sleep. Notably, a few studies demonstrated that minority children, adolescents, and their parents reported higher quality sleep despite objective evidence revealing the opposite. These discrepancies mask the true prevalence of sleep insufficiency in minorities and undermine the severity of the problem that sleep disparities pose in this population. Researchers should also work toward identifying the complex explanatory factors of racial/ethnic sleep disparities in children and adolescents, as uncovering these mechanisms is key to developing focused programs, interventions, and policies to ultimately combat youth sleep disparities and improve sleep health.

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Appendix

Table A1

Overview of proportion of studies finding disparities in various aspects of sleep

	Duration	Sleep/wake problems	Bedtime	Wake time	Sleepiness	Efficiency	Variability in duration	Quality	Fragmentation
All studies, N = 23									
Studies that found disparities	17	6	5	2	0	1	1	0	1
Total studies	18	8	5	4	1	1	1	1	1
Percentage	94.44	75.00	100.00	50.00	0.00	100.00	100.00	0.00	100.00
Studies using objective instruments, n = 6[a]									
Studies that found disparities	5	0	1	0	0	1	1	0	1

	Duration	Sleep/wake problems	Bedtime	Wake time	Sleepiness	Efficiency	Variability in duration	Quality	Fragmentation
Total studies	5	2	1	1	1	1	1	1	1
Percentage	100.00	0.00	100.00	0.00	0.00	100.00	100.00	0.00	100.00
Studies using self- or parent-reports, n = 19[b]									
Studies that found disparities	14	6	4	2	0	0	0	0	1
Total studies	15	8	4	3	1	0	0	1	1
Percentage	93.33	75.00	100.00	66.67	0.00	0.00	0.00	0.00	100.00
Studies of children only, n = 3									
Studies that found disparities	3	0	2	0	0	0	0	0	0
Total studies	3	1	2	1	0	0	0	0	0
Percentage	100.00	0.00	100.00	0.00	0.00	0.00	0.00	0.00	0.00
Studies of adolescents only, n = 10									
Studies that found disparities	7	2	1	1	0	1	1	0	1
Total studies	8	3	1	1	1	1	1	1	1
Percentage	87.50	66.67	100.00	100.00	0.00	100.00	100.00	0.00	100.00
Studies of children and adolescents, n = 10									
Studies that found disparities	7	4	2	1	0	0	0	0	0
Total studies	7	4	2	2	0	0	0	0	0
Percentage	100.00	100.00	100.00	50.00	0.00	0.00	0.00	0.00	0.00

[a] All sleep variables were not necessarily measured by objective instruments.

[b] All sleep variables were not necessarily measured by self-or parent-reports.

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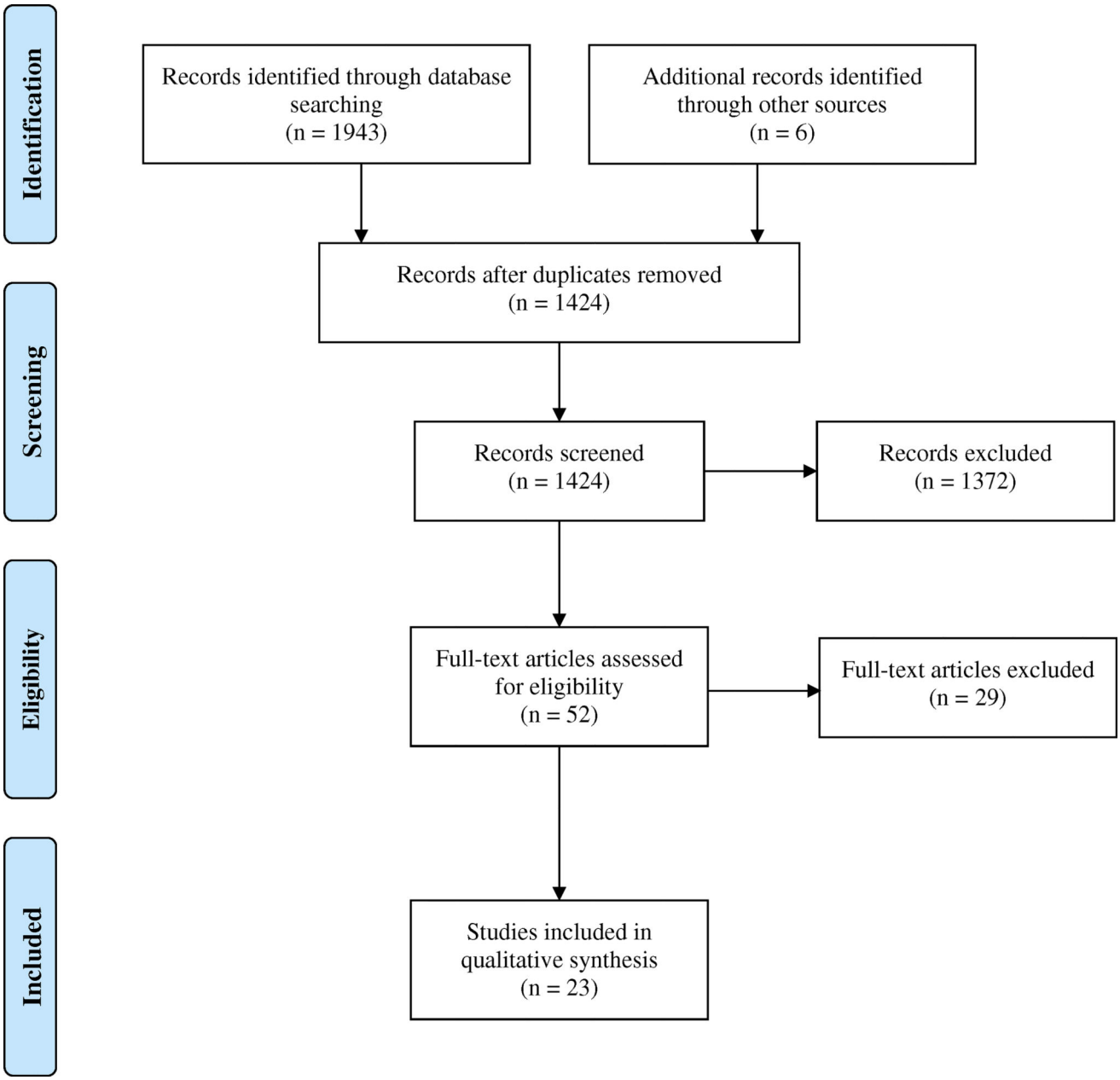

Figure 1.

Flowchart outlining article selection process, adapted from Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement.[66]

Table 1

Characteristics of studies examining racial/ethnic sleep disparities in US children and adolescents ages 6–19

First author, year	Region/community	Age range	Study design	Sample demographics	Data source
Adam, 2007[44]	Nationwide	Children (5.5–11.9 y) Adolescents (12.0–19.1 y)	Cross-sectional	N = 2454 Children (49% M; 64% W, 15% H, 14% B, 5% O, 3% As) Adolescents (49% M; 63% W, 17% B, 13% H, 4% O, 3% As)	Child Development Supplement (CDS) of the Panel Survey of Income Dynamics (PSID) (2002–2003)
Basch, 2014[38]	Nationwide	9th-to12th-grade students	Cross-sectional	N = 12,154 in 2007, N = 14,782 in 2009, N = 12,198 in 2001, N = 13,584 in 2013 Nationally representative sample of students from US public and private schools	Youth Risk Behavior Survey (YRBS) (2007, 2009, 2011, 2013)
Bates, 2016[45]	Chicago, IL	10–14 y	Prospective cohort	N = 60 100% F 63% B, 37% H	Investigator collected Community-based summer program
Combs, 2016[22]	Tucson, AZ	Median 8.8 y	Prospective cohort	N = 338 51% M 64% W, 36% H	Tucson Children's Assessment of Sleep Apnea (TuCASA) study (phase 1 and 2) Tucson Unified School District, a large district representative of the Tucson population
Eaton, 2010[39]	Nationwide	9th-to-12th-grade students	Cross-sectional	N = 12,154 Nationally representative sample of students from US public and private schools	YRBS (2007)
Goodwin, 2007[48]	Tucson, AZ	6–11 y	Cross-sectional	N = 480 50% M 58% W, 42% H	TuCASA study Sleep Habits Questionnaire Tucson Unified School District
Hawkins, 2016[37]	Nationwide	6–17 y	Cross-sectional	N = 196,990 (2003 N = 68,418; 2007 N = 63,442; 2011 N = 65,130)	National Survey of Children's Health (NSCH) (2003, 2007, 2011–2012)

First author, year	Region/community	Age range	Study design	Sample demographics	Data source
				Nationally representative sample of children and adolescents	
Keyes, 2015[1]	Nationwide	8th-, 10th-, 12th-grade students	Cross-sectional	N = 272,077 49% M 63% W, 13% B, 12% H, 8% O, 4% As	Monitoring the Future study surveys (1991–2012)
Knutson, 2009[54]	Nationwide	15–17 y	Cross-sectional	N = 130 (1981 Time Use Longitudinal Panel Study) N = 2978 (2003–2006 American Time Use Survey) M: 55% 1981; 50% 2003; 55% 2004; 50% 2005; 50% 2006 W: 89% 1981; 68% 2003; 67% 2004; 65% 2005; 67% 2006	Time Use Longitudinal Panel Study (1981) American Time Use Survey (2003–2006)
Maslowsky, 2014[40]	Nationwide	13–32 y	Prospective cohort	N = 15,701 51% M 57% W, 19% H, 17% B, 8% O	United States National Longitudinal Study of Adolescent Health (Add Health), Waves 1–4 (1994–1995, 1996, 2001–2002, 2007–2008)
Matthews, 2014[41]	Western PA	14–19 y	Cross-sectional	N = 250 46% M 57% B, 43% W	Sleep Habits Survey Single public high school
Moore, 2011[42]	Midwestern US	13–16 y	Cross-sectional	N = 247 52% M 54% minority	Cleveland TeenZzz Study Participants born at 1 of 3 Midwestern hospitals and initially participated in the Cleveland Children's Sleep and Health Study
Organek, 2015[36]	Denton, TX	11–14 y	Cross-sectional	N = 1543 49% M 63% W, 24% H, 10% B, 3% As	Investigator collected One of 6 public middle schools in the Denton Independent School District
Rao 2009[55]	Los Angeles, CA	Mean 14.8 y	Cross-sectional	N = 96 42% M 48% W, 20% H, 19% As, 14% B	Investigator collected Recruited from local pediatric clinics and schools, advertisements, and word of mouth
Roberts, 2000[50]	Houston, TX	10–17 y	Cross-sectional	N = 5423 48% M	Investigator collected One school district in the Houston metropolitan area

First author, year	Region/community	Age range	Study design	Sample demographics	Data source
				31% B, 26% H, 23% W, 20% O	
Roberts, 2004[51]	US-Mexico border	9th-grade students (median 15 y)	Cross-sectional	N = 5118 94% H, 4% W, 2% O	YRBS (2001) 13 of 40 high schools in the Lower Rio Grande Valley
Roberts, 2006[52]	Houston, TX	11–17 y	Cross-sectional	N = 4175 51% M 35% W, 35% B, 21% H, 9% O	Teen Health (2000) Households in the Houston metropolitan area that were enrolled in local health maintenance organizations
Roblyer, 2015[46]	Tulsa, OK	11–19 y	Cross-sectional	N = 91 55% M Ethnicity: 79% H Race: 81% W, 12% B, 7% O	Investigator collected Low-income local households
Singh, 2013[2]	Nationwide	6–17 y	Cross-sectional	N = 63,352 51% M 57% W, 19% H, 15% B, 4% MR, 3% As, 2% O, <1% AI, <1% NH	NSCH (2007)
Smaldone, 2007[53]	Nationwide	6–17 y	Cross-sectional	N = 68,418 Sample weighted to represent children and adolescents nationwide	NSCH (2003)
Spilsbury, 2004[49]	Cleveland, OH	8–11 y	Cross-sectional	N = 755 50% M 35% minority	Cleveland Children's Sleep and Health Study Participants born at 1 of 3 Midwestern hospitals
Williams, 2013[47]	Nationwide	0–18 y	Cross-sectional	N = 2832 in 1997 wave, N = 2520 in 2002 wave, N = 1424 in 2007 wave M: 49% 1997; 50% 2002; 49% 2007 W: 49% 1997; 48% 2002; 48% 2007	CDS of the PSID (1997, 2002, 2007)
Wong, 2013[43]	Houston, TX	9–12 y	Cross-sectional	N = 483 51% M 69% H, 31% B	Healthy Kids-Houston Study (2009–2011), a community-based after-school program

M, male; F, female; W, White; B, Black; H, Hispanic or Latino; As, Asian; NA, Native American; AI, American Indian; NH, Native Hawaiian; O, “other” race/ethnicity; MR, mixed race/ethnicity.

Table 2

Methodology and results of studies examining racial/ethnic sleep disparities in US children and adolescents 6–19 years

First author, year	Sleep variables	Covariates	Results
Study samples include children 6–13 y only			
Combs, 2016[22]	Duration (parent-reported) Bedtime (parent-reported) Wake time (parent-reported)	None	Weekdays, Hispanic children slept a median 0.5 h less than White children at phase 1 (median 9.5 h vs 10 h; $P < .0001$), and weekends, 0.3 h less (9.4 h vs 9.7 h; $P = .003$), but this disparity disappeared at phase 2 ($P = .13$). Hispanic children had later bedtimes than White children at phase 1 (9:00 PM vs 8:30 PM; $P < .0001$) and phase 2 (9:40 PM vs 9:27 PM; $P = .013$). The authors explain the lack of disparity at phase 2 by speculating that White children slept less at phase 2; that is, Hispanic children did not increase their sleep to meet Whites, but rather White children decreased their sleep to the level of Hispanic children. No significant differences in weekday wake time at phase 1 ($P = .16$) or phase 2 ($P = .847$).
Goodwin, 2007[48]	Duration (PSG; 1-d diary: parent; parent-reported) Sleep onset latency (PSG; 1-d diary: parent; parent-reported)	None	No disparities in PSG-measured duration. Parents of Hispanic children reported their child sleeping 21 min less than White children nightly (566 vs 587 min; $P < .001$) and also that they took more naps (36% Hispanics vs 19% of White parents reported their child napping; $P = .014$). No disparities in PSG-measured or parent-reported sleep onset latency.
Spilsbury, 2004[49]	Duration (1-wk diary: child) Bedtime (1-wk diary: child) Wake time (1-wk diary: child) Variability in duration (1-wk diary: child)	Age, sex, preterm status, chronic health problems, vacation status, caregiver's education	Minority boys (10–11 y) had the shortest mean sleep duration (9.12 h) for all days, whereas the rest of the sample slept 19 to 43 min longer. Minority boys (10–11 y) also had the shortest weekend sleep duration (9.25 h). Minority children were 4.8 times more likely to have a bedtime of 11 PM or later than White children (95% CI: 2.9–8.0). Minority boys and girls (10–11 y) had the latest bedtimes (10:33 PM and 10:37 PM, respectively). Minority boys and girls (10–11 y) had the greatest variability in night-tonight sleep duration for all days (CV: 11.3% and 10.8%, respectively), and minority boys (10–11 y) (CV: 10.7%) and minority girls (8 y) had the greatest variability in weekend sleep duration (CV: 11.3%). At 10–11 years old, minority boys (9.28 h) reported less sleep than nonminority girls (9.55 h, $P = .02$), non-minority boys (9.52 h, $P = .005$), and minority girls (9.53 h, $P = .01$). No significant disparities for 8- to-9-y-olds and 9- to 10-y-olds.
Study samples include both children (6–13 y) and adolescents (14–19 y)			
Adam, 2007[44]	Duration (2-d [1 weekday and 1 weekend day] diary: child) Bedtime (2-d [1 weekday and 1 weekend day] diary: child) Wake time (2-d [1 weekday and 1 weekend day] diary: child)	35 variables (demographic, school schedule, activity, and family functioning variables)	Children: Weekdays, Asian children slept 0.68 h less than White children ($P < .01$). Weekends, Hispanic children slept 0.39 h less than White children ($P < .05$). Weekdays, Asian children had later bedtimes than White children by 0.57 h ($P < .05$). Weekdays, Hispanic children woke up 0.16 h later than White children ($P < .10$). Weekends, Black children woke up 0.33 h later ($P < .01$), Hispanic children woke up 0.25 h earlier ($P < .10$), and

First author, year	Sleep variables	Covariates	Results
			Asian children woke up 0.65 h later than White children ($P < .05$). Adolescents: Weekdays, Black adolescents slept 0.42 h less than Whites ($P < .01$).Weekends, Black adolescents slept 0.47 h less ($P < .05$), and Hispanic adolescents slept 0.49 h less than Whites ($P < .10$). Weekdays, Black adolescents had later bedtimes than Whites by 0.28 h ($P < .01$). No significant difference for weekend bed times. No other older adolescent group showed significant differences for either weekday or weekend bed time. No disparities in wake time between White and either Black, Hispanic, or Asian adolescents.
Bates, 2016[45]	Duration (actigraphy) Bedtime (actigraphy) Wake time (actigraphy)	None	At baseline, Latina girls slept longer than Black girls (564 vs 518 min; $P = .006$) and had earlier sleep onset times (11:38 PM vs 12:29 AM; $P = .016$). After completing a program that promoted physical activity, Latina and Black girls had comparable sleep duration and onset times. At both time points, there were no significant differences in wake time.
Hawkins, 2016[37]	Inadequate sleep (parent-reported)	Age, sex, employment, family structure, highest education in household, health care coverage, household poverty, community/ neighborhood safety	Children: Ages 6–9 y, White (29.8%), Hispanic (26.0%), Black (29.4%), and other (26.4%) parents reported insufficiency. In adjusted regressions, Hispanics and other adolescents had lower odds of parent reported inadequate sleep (OR: 0.8 for both; 95% CI: 0.7–0.9 for both). Ages 10–13 y, White (37.5%), Hispanic (30.9%), Black (33.3%), and other (32.1%) parents reported insufficiency. In adjusted regressions, Hispanic, Black, and other adolescents had lower odds of parent reported inadequacy (OR: 0.8, 0.8, 0.7; 95% CI: 0.7–0.9 and 0.7–0.9 and −0.6 to 0.9, respectively). Adolescents: Ages 14–17 y, White (49.1%), Hispanic (35.7%), Black (39.3%), and other (45.9%) parents reported insufficiency. In adjusted regressions, Hispanic and Black adolescents had lower odds of parent reported inadequate sleep (OR: 0.7 and 0.8; 95% CI: 0.6–0.8 and 0.7–0.9, respectively).
Organek, 2015[36]	Duration (self-reported)	None	Hispanic male children (7.95 h) slept less than Asian (8.51 h) and White male children (8.44 h) ($P < .001$). No disparities between Black males (8.05 h) and males of other races/ethnicities. Black females (7.80 h) slept less than White females (8.30 h; $P < .05$). No disparities between Asian females (8.15 h) or Hispanic females (8.16 h) and females of other races/ethnicities.
Roberts, 2000[50]	Sleep disturbance: insomnia (self-reported)	Age, sex, SES	Chinese American children had approximately half (OR: 0.54) the insomnia risk of Whites almost every day ($P = .02$), and Mexican Americans had approximately 25% (OR: 1.28) increased risk for reporting insomnia often or every day ($P = .03$).
	Sleep disturbance: hypersomnia (self-reported)		Black adolescents had 2.09 the odds compared with Whites of reporting hypersomnia almost every day ($P = .000$) and 1.87 the odds of reporting hypersomnia often or almost every day

First author, year	Sleep variables	Covariates	Results
			(P = .000). Mexican Americans adolescents had 1.89 the odds of reporting hypersomnia almost every day (P = .001) and 1.63 the odds for reporting hypersomnia often or almost every day (P = .000). Central Americans had 1.85 the odds for reporting hypersomnia almost every day (P = .03) and 1.67 the odds for reporting hypersomnia often or almost every day (P = .009). Pakistani Americans and Vietnamese Americans reported increased odds of hypersomnia of often or almost every day (1.60 and 1.62, P = .04 and .006, respectively).
Roberts, 2006[52]	Insomnia symptoms (self-reported)	Age, sex, caregiver education, family income, ethnic identity, ethnic stress	Whites reported the highest prevalence of difficulty initiating sleep (8.3%, P < .05); Blacks reported the highest prevalence of night time awakenings with difficulty falling asleep again (4.3%, P < .05) and easily falling asleep again (6.7%, P < .05). No other insomnia symptoms were significant for any other group. For fully adjusted models, Whites had greater difficulty initiating sleep than Mexican Americans (OR: 1.65) and Blacks (OR: 2.07). Blacks had greater difficulty maintaining sleep and falling asleep again after awakenings than Mexican Americans (OR: 2.02). Whites had less difficulty maintaining sleep but falling asleep again compared with Blacks (OR: 0.66). No other ethnic comparison significant for fully adjusted models.
Roblyer, 2015[46]	Duration (self-reported) Difficulty maintaining sleep (self-reported)	Sex, age, grade in school, income, depressive symptoms, parental involvement, parent-child conflict, parent control	Latino children reported longer sleep duration (9.04 h vs 6.83 h; $P \leq .001$) and fewer difficulties maintaining sleep than non-Latinos ($P \leq .010$). In regression models, Latinos had longer sleep duration ($\beta = 0.35$, $P \leq .001$) and less difficulty maintaining sleep ($\beta = -0.33$, $P \leq .010$) than non-Latinos.
Singh, 2013[2]	Sleep problems: inadequate sleep (parent-reported)	21 variables (SES, demographic factors, social, physical, and built environments, and behavioral factors)	Blacks (15.31%) had the highest prevalence of b5 d/wk of adequate sleep (Hawaiian/Pacific Islander: 13.90%; Whites: 13.80%; American Indian: 13.12%; mixed: 12.70%; other: 12.32%; Asian: 12.04%; Hispanic: 10.82%; P = .40). Whites (39.40%) had the highest prevalence of b7 d/wk of adequate sleep (mixed: 38.66%; Hawaiian/Pacific Islander: 36.17%; Black: 32.75%; American Indian: 32.09%; other: 29.01%; Hispanic: 28.54%; Asian: 26.96%; P < .001). For fully adjusted logistic models, there were no significant differences among races/ethnicities for b5 d/wk of adequate sleep. For b7 d/wk of adequate sleep, Whites (OR: 1.29), mixed (OR: 1.38), and other (OR: 0.59) significantly differed from Hispanics (reference group).
Smaldone, 2007[53]	Inadequate sleep (parent-reported)	18 covariates representing demographics, child health, school and activities, family life	White children more frequently had inadequate sleep (defined as not sleeping enough on at least 1 night/wk) than Blacks, Hispanics, and "other"/multiple race/ethnicity children (ages 6–11 y: P < .01; ages 12–17 y: P < .001). Adjusting for covariates, Black children ages 6–11 y showed no significant differences from White adolescents; other than this exception, all groups (Black, Hispanic, other/mixed race/ethnicity) showed significantly lower odds of inadequate sleep compared with Whites in all age groups (6–11 y and 12–17 y). Black children aged 12–17 showed lower odds (OR = 0.73) than Whites for obtaining inadequate sleep.

First author, year	Sleep variables	Covariates	Results
Williams, 2013[47]	Duration (2-d [1 weekday and 1 weekend day] diary: parent)	Age	White children generally slept longer than black children (10- to 15-min difference depending on age group) and shorter than Hispanic children (19-min difference for ages 9 and older). Authors concluded no clinically significant disparities in duration.
Study samples include adolescents 14–19 y only			
Basch, 2014[38]	Duration (self-reported)	None	Every wave from 2007 to 2013, Black females were more likely to sleep 5 or fewer hours on school nights than White females, and this same pattern followed for Black vs White males.
Eaton, 2010[39]	Duration/insufficient sleep (self-reported)	Sex, grade level	Black adolescents (20.6%) reported having borderline (8 h) sleep significantly less than White (24.4%) and Hispanic (23.8%) adolescents ($P < .05$ for both). Black adolescents (71.2%) reported having insufficient sleep (≤7 h) significantly more than Hispanic (65.5%) adolescents ($P < .05$). Hispanic adolescents (10.6%) reported optimal sleep (≥9 h) significantly more than White (6.5%) adolescents ($P < .05$).
Keyes, 2015[1]	Duration (self-reported) Inadequate sleep (self-reported)	None	Nearly all times periods (1991–2012), Black, Hispanic, Asian, and "other" race/ethnicity adolescents were less likely to have 7 or more average hours of sleep than White adolescents. At all time periods (1991–2012), Black and Hispanic adolescents were the most likely to report regular adequate sleep of any race/ethnicity.
Knutson, 2009[54]	Time in bed (2-d [1 school day and 1 nonschool day] diary: adolescent) Bedtime (2-d [1 school day and 1 nonschool day] diary: adolescent) Wake time (2-d [1 school day and 1 nonschool day] diary: adolescent)	Age, day of week, year, sex, income, various activities	Bedtimes for Black adolescents were approximately 25 min later thanWhite adolescents ($P = .007$).Wake times were 45 min later for Asian adolescents thanWhite adolescents ($P = .04$). No other disparities betweenWhites (reference group) and the rest of the sample.
Maslowsky, 2014[40]	Duration (self-reported) Bedtime (self-reported) Wake time (self-reported)	None	Black adolescents had a higher prevalence of reporting b6 h of sleep (8.60%) thanWhite (3.98%), Hispanic (4.55%), and other (6.04%) adolescents, and higher percentages of reporting N10 h of sleep (3.53%) thanWhite (2.58%), Hispanic (2.13%), and other (2.12) adolescents. These differences were all significant ($P < .001$) except for a null difference between Hispanic and other. Black adolescents reported a mean sleep duration of 7.54 h, whereas whites reported 7.78, Hispanics reported 7.72, and other adolescents reported 7.55 h. These differences were all significant ($P < .001$), except for a null difference between Blacks and other.
Maslowsky, 2014[40]	Duration (self-reported)	None	Black adolescents had a higher prevalence of reporting b6 h of sleep (8.60%) thanWhite (3.98%), Hispanic (4.55%), and other (6.04%) adolescents, and higher percentages of reporting N10 h of sleep (3.53%) thanWhite (2.58%), Hispanic (2.13%), and other (2.12) adolescents. These differences were all significant ($P < .001$) except for a null difference between Hispanic and other.
	Bedtime (self-reported) Wake time (self-reported)		Black adolescents reported a mean sleep duration of 7.54 h, whereas whites reported 7.78, Hispanics reported 7.72, and other adolescents reported 7.55 h. These differences were all significant ($P < .001$), except for a null difference between Blacks and other.
Matthews, 2014[41]	Duration (actigraphy; 1-wk diary: adolescent)	Smoking, BMI, age, physical activity	Actigraphy

First author, year	Sleep variables	Covariates	Results
	Sleep onset delay (self-reported)		Duration was shorter for Black adolescents than whites by 0.27 standard deviation overall ($P < .001$), 0.22 standard deviation on weekdays ($P < .001$), 0.13 standard deviation on weekends ($P = .05$) (Black males 6.2 h, Black females 6.3 h; White males 6.4 h, White females 6.9 h) and 0.27 standard deviation greater fragmentation ($P < .001$).
	Daytime sleepiness (self-reported)		Diary
	Fragmentation (actigraphy)		Diary-measured duration was also shorter for Black adolescents than Whites by 0.16 standard deviation overall ($P = .01$) and 0.13 standard deviation less on weekdays ($P = .05$) (Black males 7.4 h, Black females 7.2 h; White males 7.5 h, White females 7.7 h). No significant differences for weekend duration ($P = .33$) and total quality ($P = .15$)
	Quality (self-reported)		Questionnaire
			No disparities in sleep onset delay ($P = .55$) or daytime sleepiness ($P = .66$).
Moore, 2011[42]	Duration (actigraphy) Variability in duration and wake time (actigraphy)	Age, asthma, ADHD, preterm birth, BMI, vacation status	Minority adolescents slept less than nonminority adolescents by an average of approximately 20 min nightly (464 vs 484 min; $P < .05$). Minority adolescents had greater night-to-night variability in duration (CV: 17.9% vs 14.6%; $P < .05$) than nonminority adolescents.
Rao 2009[55]	Efficiency (PSG)	SES	Adjusting for SES, Black adolescents had the lowest sleep efficiency out of any racial/ethnic subgroup ($P \leq .05$).
Roberts, 2004[51]	Duration (self-reported) Insomnia symptoms (self-reported)	Sex, age, standard of living, generational status, depressive symptoms, substance use	Unadjusted models showed a significant difference in odds of insomnia for Mexican American (Mexico born) (OR: 0.68, $P < .05$) and no significant differences for any other group compared with Whites. Adjusted odds ratios revealed that ethnicity (US Mexican American, Mexico Mexican American, and Mexican nationals vs Whites) showed no significant differences. χ^2 tests revealed no differences between ethnicities (European American, US-born Mexican American, foreign-born Mexican American, or Mexican nationals) in hours slept on weekday, weekend, waking feeling rested in the past 4 wk, difficulty initiating sleep, and early morning awakenings. Significant differences were found in presence of insomnia ($P = .0001$), overall quality of sleep ($P = .0012$), and difficulty maintaining sleep ($P = .0140$).
Wong, 2013[43]	Duration (actigraphy)	Age, sex, obesity, SES (free and reduced-price lunch)	Adjusting for SES, Hispanic children had longer sleep duration than Blacks by 0.2 h ($P < .001$).

PSG, polysomnography; CV, coefficient of variation; self-reported and parent-reported: response to questionnaire;CV, coefficient of variation.