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Adverse childhood experiences and sleep: Links in a predominantly Black sample of overweight adults

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Abstract

Adverse childhood experiences (ACEs) have been associated with worse sleep, but existing literature is limited by use of predominantly White samples, lack of objective sleep measurement, and use of non-standardized questionnaires. We investigated associations between retrospectively reported ACEs and sleep in adulthood in a sample of 43 adults 20-53 years of age, free from chronic conditions, with a BMI ≥ 25 (Mean age = 33.14 [SD = 10.05], 74% female, 54% Black). Sleep efficiency (SE), total sleep time (TST), wake after sleep onset (WASO), and sleep onset latency (SOL), were measured by actigraphy and daily diary. Global sleep quality and insomnia severity were measured by questionnaires. Sleepiness, fatigue, and sleep quality were also measured by daily diary. Adjusting for demographic characteristics and BMI, ACEs were significantly associated with poorer global sleep quality and diary measures of greater daytime sleepiness, fatigue, and poorer sleep quality. There were no significant associations between ACEs and SE, TST, WASO, or SOL measured by diary or actigraphy. Findings suggest that ACEs are associated with worse sleep perception and daytime functioning in adulthood. Larger prospective studies are needed to replicate these findings, examine racial/ethnic differences, and determine temporal associations between ACEs, sleep, and health (e.g., BMI).

Keywords

abuse; trauma; neglect; sleep quality; actigraphy; insomnia; obesity; BMI

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Introduction

Exposure to adverse childhood experiences (ACEs) is highly prevalent, with approximately 61% of adults in the US reporting at least one ACE, and 16% reporting four or more (Merrick et al., 2019). ACEs encompass a multitude of stressful or traumatic events that occur before age 18, such as abuse, neglect, and household dysfunction (Felitti et al., 1998). They are associated with some of the leading causes of disability and death, including depression, substance use disorders, obesity, cardiovascular disease, and cancer (Felitti et al., 1998; Li, D'Arcy, & Meng, 2016; Merrick et al., 2019; Rehkopf et al., 2016).

Whilst existing literature details links of ACEs with poor health outcomes, there is a need for research focused on identifying novel targets for intervention that may help reduce the excessive health burden of ACEs. Poor sleep may be a valuable intervention target, as previous data indicate that sleep disturbances may partially mediate the relationship between ACEs and mental and physical health outcomes (Hambrick, Rubens, Brawner, & Taussig, 2018; Lee, Tsenkova, & Carr, 2014; Petrov, Davis, Belyea, & Zautra, 2016; Rojo-Wissar et al., 2019). Sleep disturbances are also associated with similar mental and physical health outcomes (Zee & Turek, 2006), including obesity (Coughlin & Smith, 2014; Muscogiuri et al., 2019; Zhou, Zhang, & Hu, 2019). Consequently, ACE-related sleep disturbances may both increase the risk of incident health problems and exacerbate existing health problems.

Preliminary studies of the relationships among ACEs, sleep disturbances, and health outcomes have identified sleep as a potentially important interventional target (Hambrick et al., 2018; Lee et al., 2014; Petrov et al., 2016; Rojo-Wissar et al., 2019). However, little is known about the specific aspects of sleep (e.g., duration, sleep efficiency, wake after sleep onset, and sleep latency) with which ACEs are associated (Brown, Rodriguez, Smith, Ricker, & Williamson, 2022; Kajeepeta, Gelaye, Jackson, & Williams, 2015). Thus far, a systematic review demonstrated the association of ACEs with several sleep disorders (i.e., obstructive sleep apnea, narcolepsy, and sleep paralysis), nightmares, and insomnia symptoms (e.g., trouble falling/staying asleep; Kajeepeta, Gelaye, Jackson, & Williams, 2015). Limitations of previous studies include insufficient measurement of cumulative ACE exposure, focus on categorical diagnoses rather than on dimensional sleep parameters (e.g., total sleep time, sleep efficiency), and the predominant use of subjective reports (Brown et al., 2022; Kajeepeta et al., 2015). Another significant limitation of previous research is the primary use of samples with little or no representation of racial/ethnic minorities, who are known to be at a greater risk of experiencing both ACEs (Merrick et al., 2019) and poor sleep (Johnson, Jackson, Williams, & Alcántara, 2019a). Particularly, non-Hispanic Black people tend to experience poorer sleep compared to other racial/ethnic groups (Johnson et al., 2019a). Knowledge about which specific dimensional aspects of sleep ACEs are associated with in diverse samples will inform future prevention and interventional work.

Further, studying overweight or obese adults is also pertinent, as this population is more likely to have experienced abuse or neglect during childhood (Danese & Tan, 2014). They are also at greater risk for poor sleep during adulthood, which may in part be due to obesity-related factors such as obstructive sleep apnea, gastrointestinal disorders, increased levels of circulating pro-inflammatory cytokines, and dietary patterns (e.g., evening fat and

carbohydrate consumption) that affect inflammation and hormonal processes implicated in energy metabolism and sleep-wake rhythm regulation (Coughlin & Smith, 2014; Muscogiuri et al., 2019; Zhou et al., 2019). We sought to add to the literature on the relationship between cumulative ACEs and adult sleep health by examining these associations using both subjective and objective (i.e., actigraphic) measures of sleep duration and continuity, as well as daytime sleepiness and fatigue, in a sample of primarily Black adults who were overweight or obese, with no other significant medical conditions. We hypothesized that ACEs would be significantly associated with poorer subjective sleep quality, given previous research consistently demonstrating these links (Brown et al., 2022; Kajeepeta et al., 2015). We did not have specific hypotheses regarding the association between ACEs and the other sleep indices, given the limited previous research and mixed findings (Brown et al., 2022; Kajeepeta et al., 2015).

Methods

Participants and Procedure

The current study consisted of secondary analyses of baseline data from the Healthy Behaviors Learning Task and Sleep pilot study. This study was designed to assess the effects of a computerized learning task on weight loss (Smith, 2016). Requirements for inclusion at the screening visit were as follows: 1) age between 20-55 years; 2) BMI ≥ 25 kg/m^2; 3) nonsmoker and no nicotine use in the past six months; 4) not currently using recreational drugs; 5) desire to lose weight; 6) difficulty losing weight in the past; 7) Alcohol Use Disorders Identification Test a score of < 3 for women and < 4 for men (a score of 4 was acceptable if item 2=0 and item 3=0), 8) Pittsburgh Sleep Quality Index (PSQI) score < 8; 9) Insomnia Severity Index (ISI) score < 10; 10) Epworth Sleepiness Scale score < 10; 11) below clinical cutoff for Restless Legs Syndrome based on the Cambridge-Hopkins questionnaire (Allen, Burchell, MacDonald, Hening, & Earley, 2009); 12) apnea-hypopnea index <15; and 13) A sleep time no earlier than 20:00 and wakeup time no later than 9:00 at least 6 days per week.

Exclusion criteria were 1) Current diagnosis of diabetes (type 1 or type 2), 2) history of major medical disease impacting the study, 3) unstable medical or psychiatric condition in the past six months, 4) current use of antidepressants or opioids, 5) lifetime diagnosis of anorexia nervosa, bulimia nervosa, or alcohol or substance use disorder or dependence, 6) past year suicidal ideation, 7) lifetime serious head injury or stroke judged to impact pain or sleep, 8) current sleep disorder as assessed by the Structured Interview for Sleep Disorders, 9) current pregnancy or lactation, 10) food allergies with anaphylaxis, 11) taking > 30 minutes to fall asleep, and 12) positive toxicology screen.

Eligible participants completed a baseline visit, consisting of written informed consent, hip, waist, height, and weight measurements, questionnaires, and additional tasks pertinent to the parent study. To assess eligibility for participation in the Healthy Behaviors Learning Task and Sleep pilot study, 126 phone screens were conducted. Of those, 59 participants consented to participate, 50 were eligible at the baseline visit and completed actigraphy and a daily sleep diary. Data collection on ACEs did not begin until some participants had already completed data collection; thus, our current analysis includes 43 participants who

have data on demographic characteristics, ACEs, and sleep. The Institutional Review Board of the Johns Hopkins Medical Institutions approved the study protocol.

Measures

Adverse Childhood Experiences (ACE) Survey.—Adverse childhood experiences occurring before the age of 18 were measured using the original ACE survey (Felitti et al., 1998). Participants provided yes/no responses to 10 different ACE items, yielding a total score ranging 0-10, with higher scores indicative of increased number of ACEs. Questions assessed (1) *physical abuse* (Did a parent or other adult in the household **often or very often**…Swear at you, insult you, put you down, or humiliate you? **or** Act in a way that made you afraid that you might be physically hurt?), (2) *psychological abuse* (Did a parent or other adult in the household **often or very often**…Push, grab, slap, or throw something at you? or **Ever** hit you so hard that you had marks or were injured?), (3) *sexual abuse* (Did an adult or person at least 5 years older than you **ever**…Touch or fondle you or have you touch their body in a sexual way? **or** Attempt or actually have oral, anal, or vaginal intercourse with you?), (4) *physical neglect* (Did you **often or very often** feel that …You didn't have enough to eat, had to wear dirty clothes, and had no one to protect you? **or** Your parents were too drunk or high to take care of you or take you to the doctor if you needed it?), (5) *emotional neglect* (Did you **often or very often** feel that … No one in your family loved you or thought you were important or special? **or** Your family didn't look out for each other, feel close to each other, or support each other?), (6) *loss of a biological parent* (Was a biological parent **ever** lost to you through divorce, abandonment, or other reason?), (7) *household substance abuse* (Did you live with anyone who was a problem drinker or alcoholic or who used street drugs?), (8) *domestic violence* (Was your mother or stepmother: **Often or very often** pushed, grabbed, slapped, or had something thrown at her? **or** Sometimes, often, or very often kicked, bitten, hit with a fist, or hit with something hard? **or** Ever repeatedly hit at least a few minutes or threatened with a gun or knife? [asked about father or stepfather as well]), (9) *household mental illness* (Was a household member depressed or mentally ill, or did a household member attempt suicide?), and (10) *incarceration of a household member* (Did a household member go to prison?).

Actigraphy.—Participants were asked to wear actigraphs (ActiGraph GT3X, ActiGraph Corp, Pensacola FL) continuously on their non-dominant wrist for seven consecutive days, consistent with recommendations for actigraphy in sleep research (Ancoli-Israel et al., 2015). Records were scored according to standardized procedures developed by the Behavioral Medicine Research Laboratory (Ancoli-Israel et al., 2015). These procedures included use of sleep diary bed and rise times indicated by participants to determine in-bed intervals, and the Cole-Kripke scoring algorithm (Cole, Kripke, Gruen, Mullaney, & Gillin, 1992). Average values across wear time were derived from scored records for the following sleep indices: total sleep time (TST; i.e., sleep duration) in minutes, sleep efficiency (SE; i.e., the proportion of time spent in bed actually sleeping) expressed as a percentage, and wake after sleep onset (WASO; i.e., total duration of all night awakenings) in minutes. Due to a heavily skewed distribution of sleep onset latency (SOL; i.e., time taken to fall asleep), this was not used in analyses as an outcome.

Daily Sleep Diaries.—Participants completed sleep diaries each morning and evening for seven days. Morning sleep diaries were based on the consensus sleep diary (Carney et al., 2012), and included nine questions relating to bedtimes and rise-times, subjective SOL, WASO, number of awakenings, and subjective sleep quality ("*Please rate your overall sleep quality last night on the following scale":* 0 (extremely poor) to 10 (excellent)). Responses from sleep diaries were used to quantify TST, SE, WASO, and SOL by averaging responses across nights. The evening diary assessed daily fatigue ("*Please rate your typical (average) level of fatigue for the day*": 0 (none) to 10 (extreme fatigue)) and sleepiness *("Please rate your typical (average) level of sleepiness for the day":* 0 (completely alert) to 10 (fighting to stay awake)), which were also averaged across nights.

Pittsburgh Sleep Quality Index (PSQI).—The Pittsburgh Sleep Quality Index was used to assess global sleep quality (Buysse, Reynolds, Monk, Berman, & Kupfer, 1988). Participants rated sleep quality over the preceding month using 19 self-scored questions scored 0 (no difficulty) to 3 (severe difficulty). Higher scores indicate poorer sleep.

Insomnia Severity Index (ISI).—The Insomnia Severity Index was used to quantify insomnia severity (Morin, Belleville, Bélanger, & Ivers, 2011). The ISI is a 7-item questionnaire measuring night-time and daytime insomnia symptoms. Response options for each item were a five-point Likert scale (0 = no problem, 4 = very severe problem), which were summed to derive a total score. Higher scores indicate more severe insomnia.

Other Measures.—Participants reported their age in years and sex (male or female), race/ethnicity ("White", "Black", and "Other"), and education ("High school grad/GED, Tech. school grad, or lower", "Some college", and "Bachelors or Masters degree"). Height in inches and weight in pounds were measured in lab. Body mass index (BMI) was calculated as [weight(lbs) / height(in)^2 * 703].

Data Analysis

Statistical program Stata version 16.0 was used to conduct all analyses (StataCorp, College Station, TX). First, descriptive statistics were computed for the full sample, and by race/ethnicity. To determine whether there were differences in descriptive characteristics by race/ethnicity, ANOVAs were run for continuous characteristics, and chi-square analyses for categorical characteristics. Next, a Pearson correlation matrix of ACEs, BMI, and sleep-related variables was generated. Lastly, individual linear regression models were used to examine associations between reports of cumulative ACEs (predictors) and the following sleep metrics (outcomes): TST, SE, and WASO measured both by actigraphy and daily diary, daily diary reports of average fatigue, sleepiness, and sleep quality, and scores on the ISI and PSQI questionnaires. Only diary-measured SOL was included as an outcome.

Three models were fit for each sleep outcome: Model 1 (unadjusted); Model 2 (consistent with previous studies, adjusted for age, race/ethnicity, sex, and education(Brindle et al., 2018; McWhorter et al., 2019; Sheehan, Li, & Friedman, 2020)); and Model 3 (adjusted for Model 2 covariates and BMI), to determine the extent to which ACEs were associated with sleep outcomes beyond the effects of BMI. Unstandardized regression coefficients were

used to interpret the estimates as the unit change in sleep outcome (e.g., in minutes) per unit increase in ACE score.

Standardized coefficients were also generated to compare the relative strengths of the associations of ACEs with each outcome. The standardized estimates can be interpreted as the standard deviation increase in the sleep outcome per standard deviation increase in ACE score. Due to missing data, the analytic samples differ for each outcome: self-report questionnaires, $n = 43$; daily diary, $n = 38$; and wrist actigraphy, $n = 36$. Participant characteristics were similar across samples. Thus, we used an available case analysis to increase power, given the small samples.

Results

Sample Characteristics

Participants had a mean age of 33.14 years, (SD = 10.05 years), 74% were female, 54% were Black, and average BMI in the sample was 33.75 (SD = 6.59 (Table 1). There were no statistically significant differences in demographic (i.e., age, sex, education), BMI, ACE, or sleep characteristics by race/ethnicity. Correlations among ACEs, BMI, and the sleep-related variables are reported in Table 2.

Associations between ACEs and sleep

Associations between ACEs and sleep are reported in Table 3.

Wrist Actigraphy.—ACEs were not significantly associated with actigraphy-measured SE, TST, or WASO.

Daily Diary.—ACEs were significantly associated with diary measures of sleep quality and daytime symptoms of sleepiness and fatigue. In unadjusted Model 1, each unit increase in number of ACEs was significantly associated with a 0.47-point increase in average daytime sleepiness (B = 0.47; 95% confidence interval [CI] = 0.18, 0.77), a 0.41-point increase in average daytime fatigue (B = 0.41; 95% CI = 0.13, 0.70), and a 0.40-point decrease in average sleep quality (B = −0.40; 95% CI = −0.63, −0.17). These associations were somewhat attenuated, but remained significant in Model 2, when adjusting for demographic characteristics (i.e., age, sex, education, and race/ethnicity), and in Model 3 when further adjusting for BMI.

When examining the standardized β coefficients to compare the relative strength of the associations between ACEs and daily diary measures, ACEs had the strongest association with sleep quality (Model 3: β = −0.44). Each SD increase in ACE score was associated with a 0.44 SD decrease in sleep quality, and a 0.39 SD increase in both sleepiness (Model 3: β = 0.39) and fatigue (Model 3: β = 0.39). ACEs were not significantly associated with SE, TST, WASO, or SOL.

Self-Report Questionnaires.—In Model 1 (unadjusted), each unit increase in number of ACEs was associated with a 0.47-point increase in PSQI score, indicating poorer sleep quality (B = 0.47; 95% CI = 0.13, 0.81). This association remained when adjusting for

demographic characteristics in Model 2, and when further adjusting for BMI in Model 3. The standardized results in fully adjusted Model 3 suggest that each SD increase in ACE score was associated with a 0.36 SD increase in PSQI score.

In Model 1, each unit increase in number of ACEs was associated with a 0.53-point increase in ISI scores, indicating greater insomnia severity (B = 0.53; 95% CI = 0.05, 1.01). This association was no longer significant in Models 2 and 3.

Discussion

The current study expands the literature on cumulative ACEs and adult sleep by examining these associations using both subjective and objective indices of dimensional sleep parameters (i.e., TST, SE, WASO, and SOL), as well as reports of sleep quality, daytime sleepiness, and daytime fatigue. Further, we focused on a sample of adults who were overweight or obese and predominantly Black —groups in which ACEs are more common (Danese & Tan, 2014; Merrick et al., 2019). This study responds to the call for research on early life adversity and sleep to include diverse populations, standardized questionnaires, and objective measures of sleep (Brown et al., 2022). While many of these constructs have been examined individually, they are rarely addressed comprehensively within the same populations, thereby limiting comparisons between variables and conclusions that can be drawn, including the generalization of findings to diverse populations. We found that increased ACE exposure was linked with subjective measures of poor sleep quality (both diary derived and PSQI), even in fully adjusted models that included BMI. ACEs were also linked with increased diary-measured daytime sleepiness and fatigue. Actigraphy and other diary-based dimensional sleep measures (i.e., SE, TST, WASO, and SOL), however, were not associated with ACEs.

Our findings that ACEs were associated with greater daytime sleepiness and fatigue, poorer sleep quality, and insomnia symptom severity (in an unadjusted model) are consistent with prior studies demonstrating links of ACEs with self-reported troubled sleep (Baiden, Fallon, den Dunnen, & Boateng, 2015), insomnia symptoms (Chapman et al., 2011; Oshri, Kogan, Liu, Sweet, & Mackillop, 2017), global sleep quality (Rojo-Wissar et al., 2019; Sheehan et al., 2020), and chronic fatigue syndrome risk in adulthood (Heim et al., 2006). Results are also consistent with findings from a recent systematic review, where the aspect of sleep in adulthood most consistently linked to child maltreatment was subjective sleep quality (Brown et al., 2022). Contrary to previous research showing that ACEs were associated with insomnia symptoms when adjusting for demographic characteristics (Chapman et al., 2011), we found that ACEs were only related to insomnia severity in an unadjusted model in the current study. These differences may be due to lower statistical power given our small sample size, and that participants with clinically significant insomnia symptoms were excluded from the parent study.

Previous research on the other sleep indices that we examined (i.e., SOL, SE, WASO, and TST) is sparse, ACE and sleep measurement has greatly varied, and findings have been mixed (Brown et al., 2022; Kajeepeta et al., 2015). Here, we compare our findings to the previous studies on ACEs and adult sleep that have specifically measured these sleep

parameters via daily diary and/or actigraphy (Brindle et al., 2018; Fusco, 2020; Hamilton, Brindle, Alloy, & Liu, 2018; Pfaff & Schlarb, 2021; Sheehan et al., 2020). We found no associations of ACEs with sleep indices (i.e., SOL, SE, WASO, and TST) measured by wrist-actigraphy or daily diary. Of the three previous studies that examined SOL (Fusco, 2020; Pfaff & Schlarb, 2021; Sheehan et al., 2020), only one found an association with ACEs, such that ACEs were associated with longer SOL (Sheehan et al., 2020). Of the three studies that looked at SE (Brindle et al., 2018; Pfaff & Schlarb, 2021; Sheehan et al., 2020), two found that ACEs were significantly associated with less SE (Brindle et al., 2018; Sheehan et al., 2020), though one effect was very small. Of the two studies that looked at WASO (Pfaff & Schlarb, 2021; Sheehan et al., 2020), one found that ACEs were significantly associated with greater WASO (Sheehan et al., 2020). Lastly, of the five previous studies that looked at TST (Brindle et al., 2018; Fusco, 2020; Hamilton et al., 2018; Pfaff & Schlarb, 2021; Sheehan et al., 2020), only one found that ACEs were significantly associated with shorter TST (Fusco, 2020). Inconsistent findings could be due to differences between studies in the populations and ACEs examined, and in the potential confounders included in analyses. More investigations of the relationship between ACEs and dimensional sleep parameters is warranted to clarify these associations.

Very few studies have included analyses examining associations between ACEs and sleep among Black participants (Boynton-Jarrett et al., 2021; Gaston et al., 2020; Oshri et al., 2017; Rojo-Wissar et al., 2021). However, results from those that have done so are generally consistent with our own: that ACEs were associated with reports of poorer sleep quality and more severe insomnia symptoms. Of note, the magnitude of effects found in our study appear larger compared to others in which participants were predominantly White and had a larger range of BMIs (Brindle et al., 2018; Sheehan et al., 2020). However, one study among Black women found no differences in associations between ACEs and adult sleep by BMI category (Boynton-Jarrett et al., 2021). Thus, our findings of larger effects may be due to our sample consisting of predominantly Black adults and not due to BMI, although additional research is needed to formally examine this. In terms of mechanisms, persistent stress-related hyperarousal may link ACEs to poorer sleep (Pfaff, Jud, & Schlarb, 2021). Both Black individuals and overweight/obese individuals are more likely to experience everyday discrimination and microaggressions, which may amplify the effects of ACEs on health outcomes, and directly affect sleep quality/insomnia symptoms (Cheng et al., 2020; Jackson, 2017).

Future research in larger samples with a broader range of racial/ethnic minority groups represented are needed to examine potential racial/ethnic disparities in the relationship between ACEs and sleep more broadly, given the sparse data in this area (Albers et al., 2022; Gaston et al., 2020; Rojo-Wissar et al., 2021). Future studies should also include measures of discrimination and measures of SES (i.e., education, income, and occupation), which may interact with ACEs to affect sleep among racial/ethnic minorities or account for racial/ethnic disparities in the ACEs-sleep relationship (Cheng et al., 2020; Johnson, Jackson, Williams, & Alcántara, 2019b). Inclusion of participants with a larger range of BMIs would also allow us to examine whether associations between ACEs and sleep differ by BMI.

Strengths and Limitations

The small sample size in this study may have resulted in insufficient statistical power to detect small or medium main effects between ACEs and sleep indices. We were also unable to examine whether the relationship between ACEs and sleep indices differ by sex or race/ethnicity, given the small sample size. Our sample of participants who also did not have clinically significant sleep problems at screening may have further reduced our ability to detect effects of ACEs on some sleep indices (i.e., SOL, SE, WASO, and TST), though also demonstrated that the relationships among ACEs and other sleep indices (e.g., daytime sleepiness and fatigue) are still present, even in generally healthy individuals. Despite these two limitations, we observed associations of ACEs with measures of subjective sleep quality and daytime symptoms of sleepiness and fatigue.

The generalizability of this study may also be somewhat limited, given the use of a sample of overweight or obese adults who were free from clinically significant medical conditions including sleep issues. Examining these associations in overweight or obese adults is notable however, given the reliable relationship between ACEs and obesity (Merrick et al., 2019; Rehkopf et al., 2016), as is the racial diversity of the sample. Additional notable strengths include assessment of the effects of cumulative ACE exposure from a wide array of ACEs, and examination of the effects of ACEs on multiple dimensions of sleep, measured behaviorally by wrist-actigraphy, and subjectively by daily diary and standardized questionnaires.

Clinical Significance

Our results suggest that ACEs are associated with poorer sleep quality, as well as daytime complaints of fatigue and sleepiness, in adulthood. Given that sleep disturbances are associated with negative mental and physical health outcomes (Zee & Turek, 2006), sleep disturbances may be one pathway by which ACEs affect lifelong health. If future longitudinal studies support an association between ACEs and sleep, then screening for and treating sleep disturbances in children with ACEs may help prevent onset of poor health consequences associated with ACEs, such as obesity, depression, and anxiety. Previous research has shown for example, that sleep disturbances tend to precede the development of internalizing disorders, and treating sleep problems in adolescents has been shown to improve mental health symptoms (Blake & Allen, 2020). Identifying and treating these sleep disturbances may result not only in improvements in sleep but could also lead to a cascade of downstream improvements in general emotional functioning beneficial to mental health outcomes. For example, Cognitive Behavioral Therapy for Insomnia (CBT-I) is effective in reducing subjective sleep impairments in individuals with insomnia disorder (van Straten et al., 2018), and those with sleep complaints secondary to a medical disorder (McGrath et al., 2017). It has also been shown to result in improvements in paranoia, anxiety, depression, and chronic pain (Ballesio et al., 2018; Freeman et al., 2017; Smith et al., 2015; Tang et al., 2015; Vitiello, Rybarczyk, Von Korff, & Stepanski, 2009). In addition to implementation as a standalone treatment, CBT-I components could also be integrated into existing trauma interventions when sleep-related and trauma disorder symptoms co-occur, potentially resulting in more favorable clinical outcomes for children and adults. Identifying and treating sleep issues in overweight or obese adults with a history of ACEs could also

have implications for weight loss efforts or weight gain prevention. For example, a previous randomized clinical trial found that weight loss interventions may be more effective in individuals with healthy sleep duration at baseline (Elder et al., 2012; Logue et al., 2012).

Conclusion

Cumulative adverse childhood experiences were associated with poorer sleep quality and greater daytime sleepiness and fatigue in a sample of predominantly Black overweight or obese adults free from other significant medical conditions. Findings contribute to the sparse literature examining the links between ACEs and sleep in racial/ethnic minorities. Future research in larger samples is needed to formally examine racial/ethnic disparities in the links between ACEs and sleep and further clarify these relationships.

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Data Accessibility Statement:

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Table 1

Participant Characteristics for the Full Sample, and by Race/Ethnicity, Mean (± SD) or n (%)

	Total	Black participants	White participants	Other participants	p-value
Demographic and Health Characteristics	***N = 43***	***n = 23***	***n = 11***	***n = 9***	
Age	33.14 (10.05)	34.61 (10.87)	32.55 (10.24)	30.11 (7.61)	0.521
Sex					0.285
Male	11 (26%)	4 (17%)	3 (27%)	4 (44%)	
Female	32 (74%)	19 (83%)	8 (73%)	5 (56%)	
Education					0.694
High school grad/GED, Tech. school grad, or lower	17 (40%)	11 (48%)	3 (27%)	3 (33%)	
Some college	10 (23%)	4 (17%)	4 (36%)	2 (22%)	
Bachelors or Masters degree	16 (37%)	8 (35%)	4 (36%)	4 (44%)	
BMI	33.75 (6.59)	34.61 (6.41)	33.82 (7.30)	31.44 (6.33)	0.483
ACE Score	2.00 (1.98)	1.91 (1.98)	2.27 (1.74)	1.89 (2.42)	0.874
Sleep Outcome					
Wrist Actigraphy	**N = 36**	**N = 20**	**N = 10**	**N = 6**	
Sleep Efficiency, %	86.54 (5.48)	85.65 (5.88)	86.24 (5.37)	89.98 (3.11)	0.238
Total Sleep Time, minutes	388.65 (39.01)	386.89 (43.59)	391.99 (40.46)	388.92 (21.22)	0.948
Wake After Sleep Onset, minutes	57.47 (26.47)	61.52 (29.57)	58.71 (23.68)	41.90 (14.56)	0.285
Sleep Onset Latency, minutes	5.64 (8.58)	7.02 (10.68)	5.43 (5.38)	1.38 (0.38)	0.378
Daily Diary	**N = 38**	**N = 20**	**N = 10**	**N = 8**	
Sleep Efficiency, %	90.56 (5.97)	90.22 (6.52)	91.69 (4.49)	89.98 (6.67)	0.789
Total Sleep Time, minutes	438.59 (44.80)	448.31 (47.56)	434.21 (35.40)	419.77 (46.41)	0.302
Wake After Sleep Onset, minutes	8.86 (14.19)	10.00 (17.84)	10.58 (10.61)	3.85 (4.29)	0.541
Sleep Onset Latency, minutes	14.22 (9.82)	12.69 (9.16)	14.87 (12.08)	17.23 (8.73)	0.539
Sleepiness	2.65 (1.89)	2.47 (2.01)	3.25 (2.20)	2.35 (0.94)	0.510
Fatigue	2.73 (1.79)	2.52 (1.95)	3.29 (2.03)	2.56 (0.86)	0.535
Sleep Quality	6.94 (1.49)	7.33 (1.57)	6.17 (1.32)	6.92 (1.25)	0.132
Self-report Questionnaire	**N = 43**	**N = 23**	**N = 11**	**N = 9**	

	Total	Black participants	White participants	Other participants	p-value
Demographic and Health Characteristics	***N = 43***	***n = 23***	***n = 11***	***n = 9***	
Pittsburgh Sleep Quality Index Score	3.14 (2.35)	3.13 (2.60)	2.73 (1.62)	3.67 (2.55)	0.683
Insomnia Severity Index Score	2.91 (3.20)	2.48 (3.46)	3.18 (2.36)	3.67 (3.54)	0.617

Note. ACE = adverse childhood experience, BMI = body mass index. ANOVAs were run to examine group differences in continuous variables by race/ethnicity, and chi-square analyses were run to examine group differences in categorical variables by race/ethnicity.

Table 2

Correlation matrix of Adverse Childhood Experiences and Sleep-related Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13
1.ACE score	1												
2.BMI	0.17	1											
3.Actigraphy SE	−0.09	**−0.41**	1										
4.Actigraphy TST	−0.01	0.02	0.24	1									
5.Actigraphy WASO	0.27	**0.39**	**−0.85**	0.13	1								
6.Diary SE	−0.18	**−0.36**	0.22	−0.18	**−0.35**	1							
7.Diary TST	0.13	−0.12	0.01	**0.56**	0.17	0.20	1						
8.Diary WASO	0.31	**0.46**	0.02	0.13	0.07	**−0.53**	−0.07	1					
9.Diary SOL	0.12	0.14	0.00	**0.32**	0.24	**−0.58**	0.02	**0.31**	1				
10.Diary Sleepiness	**0.48**	0.27	−0.12	0.07	0.15	−0.01	−0.06	0.22	−0.01	1			
11.Diary Fatigue	**0.44**	0.20	−0.06	0.16	0.10	0.03	−0.08	0.14	0.02	**0.90**	1		
12.Diary Sleep Quality	**−0.51**	**−0.33**	0.09	0.02	−0.17	**0.42**	0.25	−0.27	−0.21	−0.27	−0.22	1	
13.PSQI	**0.40**	**0.29**	−0.05	−0.07	0.18	−0.26	−0.02	0.10	**0.42**	0.24	0.15	**−0.47**	1
14.ISI	**0.33**	0.25	−0.12	−0.01	0.20	−0.25	−0.01	0.05	0.16	0.22	0.04	**−0.50**	**0.65**

Note. PSQI = Pittsburgh Sleep Quality Index, ISI = Insomnia Severity Index; significant correlations are bolded.

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Table 3

Associations between Number of Adverse Childhood Experiences and Sleep Indices in the Full Sample

Sleep Outcome	Model 1				Model 2				Model 3			
Wrist Actigraphy (n = 36)	**B**	**β**	**95% CI**	**R^2**	**B**	**β**	**95% CI**	**R^2**	**B**	**β**	**95% CI**	**R^2**
Sleep Efficiency	−0.27	−0.09	[−1.34, 0.81]	0.01	−0.37	−0.12	[−1.44, 0.70]	0.29	−0.21	−0.07	[−1.31, 0.88]	0.33
Total Sleep Time	−0.28	−0.01	[−7.96, 7.40]	0.00	−0.92	−0.04	[−8.86, 7.02]	0.23	0.020	0.00	[−8.18, 8.23]	0.26
Wake After Sleep Onset	4.07	0.27	[−0.95, 9.08]	0.07	4.64	0.31	[−0.83, 10.10]	0.21	4.21	0.28	[−1.49, 9.91]	0.22
Daily Diary (n = 38)	**Model 1**				**Model 2**				**Model 3**			
	B	**β**	**95% CI**	**R^2**	**B**	**β**	**95% CI**	**R^2**	**B**	**β**	**95% CI**	**R^2**
Sleep Efficiency	−0.55	−0.18	[−1.60, 0.49]	0.03	−0.92	−0.29	[−2.12, 0.28]	0.13	−0.75	−0.24	[−1.96, 0.46]	0.18
Total Sleep Time	2.99	0.13	[−4.93, 10.92]	0.02	0.7	0.03	[−8.16, 9.56]	0.16	2.12	0.09	[−6.68, 10.93]	0.23
Wake After Sleep Onset	2.31	0.31	[−0.10, 4.71]	0.09	2.37	0.32	[−0.41, 5.14]	0.18	1.79	0.24	[−0.88, 4.47]	0.29
Sleep Onset Latency	0.62	0.12	[−1.11, 2.36]	0.01	1.04	0.20	[−0.94, 3.03]	0.12	0.96	0.19	[−1.10, 3.02]	0.12
Sleepiness	0.47**	0.48**	[0.18, 0.77]	0.23	0.40*	0.40*	[0.06, 0.74]	0.29	0.39*	0.39*	[0.03, 0.74]	0.30
Fatigue	0.41**	0.44**	[0.13, 0.70]	0.19	0.37*	0.39*	[0.04, 0.70]	0.26	0.37*	0.39*	[0.02, 0.71]	0.26
Sleep Quality	−0.40**	−0.51**	[−0.63, −0.17]	0.26	−0.39**	−0.50**	[−0.63, −0.15]	0.44	−0.35**	−0.44**	[−0.58, −0.11]	0.50
Self-report Questionnaire (n = 43)	**Model 1**				**Model 2**				**Model 3**			
	B	**β**	**95% CI**	**R^2**	**B**	**β**	**95% CI**	**R^2**	**B**	**β**	**95% CI**	**R^2**
PSQI Score	0.47**	0.40**	[0.13, 0.81]	0.16	0.47*	0.39*	[0.09, 0.85]	0.24	0.43*	0.36*	[0.06, 0.80]	0.30
ISI Score	0.53*	0.33*	[0.05, 1.01]	0.11	0.47	0.29	[−0.03, 0.98]	0.28	0.44	0.27	[−0.07, 0.94]	0.30

Note. Model 1 = unadjusted, Model 2 = adjusted for age, sex, race/ethnicity, and education, Model 3 = adjusted for Model 2 covariates and body mass index; B = unstandardized regression coefficients (95% CIs are unstandardized), β = standardized regression coefficients; PSQI = Pittsburgh Sleep Quality Index, ISI = Insomnia Severity Index;

* p < .05,

** p < .01,

*** p<.001.