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Original Article

Associations of adverse childhood experiences (ACEs) with sleep duration and quality: the BCOPS study

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ABSTRACT

Background: Adverse Childhood Experiences (ACEs) are associated with numerous adverse health outcomes in adulthood. Our objective was to investigate associations between ACEs and sleep measures among 206 police officers from the Buffalo Cardio-Metabolic Occupational Police Stress study.

Methods: ACEs (independent variable) was assessed using the ACE questionnaire. Sleep measures were assessed using the Pittsburgh Sleep Quality Index and actigraphy. ANOVA/ANCOVA were used to investigate associations between ACEs and sleep measures.

Results: The mean self-reported sleep duration was significantly lower among participants who reported ≥1 ACEs compared to those who reported no ACEs (6.0 ± 0.11 vs. 6.4 ± 0.14 h; multivariate-adjusted p = 0.035). Sleep efficiency was significantly lower among participants who reported ≥1 ACEs compared to those who reported none (mean = 88.7%, 95% CI = 87.7–89.6 vs. 90.2%, 89.2–91.2; unadjusted p = 0.031) but was slightly attenuated and lost statistical significance after multivariate-adjustment (88.8%, 87.8–89.7 vs. 90.1%, 88.9–91.1; p = 0.094). Compared to participants who reported no ACEs, those who reported ≥1 ACEs had a higher mean activity index score (36.9 ± 0.96 vs. 31.2 ± 1.25; multivariate-adjusted p = 0.001); a higher mean wake after sleep onset (WASO) (44.3 ± 2.24 vs. 35.3 ± 2.92 min; multivariate-adjusted p = 0.019); and a higher sleep fragmentation index (3.8 ± 1.65 vs. 3.3 ± 1.20 unadjusted p = 0.044 and 3.8 ± 0.13 vs. 3.3 ± 0.18; multivariate-adjusted p = 0.062). Among men (but not women) who reported ≥1 ACEs, self-reported sleep duration was significantly lower (5.9 ± 0.13 vs. 6.4 ± 0.15 h; multivariate-adjusted p = 0.025) and activity index was significantly higher (39.1 ± 1.3 vs. 33.2 ± 1.51; multivariate-adjusted p = 0.004) compared to those who reported no ACEs.

Conclusion: Exposure to ≥1 ACE was associated with worse sleep measures.

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1. Introduction

Adverse Childhood Experiences (ACEs) are experiences of a traumatic nature to which persons are exposed before the age of 18 years. Increasing evidence shows that ACEs are associated with numerous adverse health outcomes in adulthood [1]. In one study, ACEs were found to be associated with a two-fold higher odds of anxiety disorders, internalizing disorders, depression, and suicidality [2]. These associations did not significantly vary by gender or the age of exposure. In other studies, persons exposed to multiple ACEs had an increased risk of asthma onset by 31% compared to those exposed to ≤1 ACE [3], a 70–100% increased risk for hospitalization with rheumatic diseases and other autoimmune diseases [4], increased anger expression and perceived stress [5], and elevated psychological distress, reduced emotional wellbeing, autonomic dysregulation, alterations in nocturnal heart rate and heart rate variability [6].

Exposure to ACEs has also been found to affect sleep quality and quantity in adulthood. Among 863 U.S. adults (25–76 years) who

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participated in the Biomarker Project in the Midlife in the United States Refresher study, experiencing more adverse events or adverse events in both childhood and adolescence was associated with worse self-reported sleep and actigraphic sleep, including longer sleep-onset latency, lower sleep efficiency, and longer wake after sleep onset (WASO) [7]. Data from the 2011 Behavioral Risk Factor Surveillance System showed that adults with three or more ACEs were over twice as likely to report short (<6 h/night) versus optimum sleep duration than those with no ACEs [8].

High quality and an adequate quantity of sleep are critical elements for optimum performance and good health [9]. There is abundant evidence showing that inadequate and poor sleep is associated with serious health conditions. Grandner (2017) describes several of these conditions in a review article [10]. The conditions include increased mortality risk [11], increased weight gain [12,13], risk of diabetes [14,15], higher levels of systemic inflammation [16,17], increased risk of cardiovascular disease [18], cognitive problems [19], mental health problems [20], and increased risk of suicide [21].

Americans do not get enough sleep. A study conducted among 444,306 adults in all 50 states and the District of Columbia found that 65.2% of respondents reported a healthy sleep duration (≥7 h/24-h period) [22]. The age-adjusted prevalence of ≥7 h of sleep in a 24-h period was lower among non-Hispanic blacks, American Indians/Alaska Natives, Native Hawaiians/Pacific Islanders, and multiracial respondents, compared with non-Hispanic whites, Hispanics, and Asians. Insufficient sleep affects several aspects of professional and personal life. In the National Sleep Foundation's 2020 Sleep in America poll, 40% of adults say feeling sleepy at least occasionally interferes with their daily activities [23].

Adequate and good quality sleep is beneficial to persons in all professions but may be most critical for workers whose jobs involve life and death decisions such as air traffic controllers, health care professionals, and the various first responders. To the best of our knowledge there have been no published studies investigating associations between ACEs and sleep quantity or quality among police officers. The objective of this study was to investigate associations of ACEs with self-reported sleep duration and several objective sleep measures among police officers. We hypothesized that higher ACE scores would be significantly associated with worse sleep measures.

2. Material and methods

2.1. Study design and participants

Participants were police officers from the Buffalo, New York, Police Department enrolled in the Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) study. The BCOPS study was undertaken to investigate associations between work-related stressful exposures and subclinical measures of cardiovascular disease (CVD) [24]. The baseline examination of the BCOPS study took place from June 2004 through October 2009 where 464 active-duty and retired police officers (from an estimated 710 officers in 2004) were recruited. The 464 officers reviewed and signed informed consent forms before the examinations. Female officers who were pregnant at the time of examination were excluded (n = 2). The Institutional Review Board at the University at Buffalo approved the studies. Data were collected at the Center for Health Research, School of Public Health and Health Professions, University at Buffalo, State University of New York [24].

Data for the current study are based on a subset of officers who participated in the second follow-up examination that took place during 2015–2019 (n = 240). As was the case in the baseline exam, officers underwent a six-hour examination. From the original 240 participants, 206 (60 women and 146 men) had non-missing data on the ACE, actigraphy, and PSQI variables and were included in the current study.

2.2. Assessment of adverse childhood experiences (ACEs)

Police officers completed the Adverse Childhood Experiences questionnaire which contains 10 questions about traumatic events of a violent or sexual nature that may have occurred to them or an immediate family member anytime during the first 18 years of their lives [25]. To each question, the participants indicated whether they have experienced the event or not (yes or no). If the participant experienced the event it was assigned a score of 1 otherwise it was assigned a score of zero. The scores for each question were then summed to obtain the total ACE score (maximum of 10). Total ACE score (dichotomized: 0 vs. ≥1) served as the independent (exposure) variable of interest for the current analyses. In an additional analysis, responses to selected individual ACE items (yes vs. no) were used as independent variables.

2.3. Assessment of sleep measures

Self-reported sleep duration: Sleep duration was assessed using the Pittsburgh Sleep Quality Index (PSQI) questionnaire [26]. It was obtained by asking the participants the question “How many hours of sleep did you get at night (during the past month)?” Studies have shown that the PSQI has high internal homogeneity, reliability, and validity [26,27].

Objective sleep measures: Objective sleep measures were assessed using actigraphy. The participants were each given a wrist Actiwatch during their clinic examination and were instructed to wear the device on their non-dominant wrist for 15 consecutive days. The actigraphy data were collected using the Micro Motion Logger Sleep Watch™ (Ambulatory Monitoring Inc., NY) and were analysed using the Action-W software with Cole Kripke algorithm for sleep scoring. Numerous parameters that describe sleep quantity and other sleep measures were then derived. This software automatically scored sleep/wake cycles and then estimated sleep parameters for each day as well as the overall average for all days. Each participant was instructed to press the event marker button of the Actiwatch at the beginning and end of a sleep period which was used to mark time in bed (TIB). They also completed a sleep diary for the same period, which was used for the actigraphy data editing. For the sleep diary, the participants were instructed to record all times when they removed the Actiwatch (eg, taking a shower). They also documented the times they got into bed and when they woke up, the start time of work and number of work hours in the sleep diary. Information from the sleep diary was used to validate the information obtained from the actigraph. The estimate for each sleep measure was the average across the number of days (required at least three consecutive days) the Actiwatch was worn.

The objective sleep measures used in this study are defined below.

1. *Sleep hours* was defined as the number of hours the participant was asleep during time in bed (TIB). It was the total number of minutes that the subject was coded as asleep during time in bed divided by 60.
2. *Sleep efficiency* (%) was calculated as the proportion of time a subject was asleep during time in bed.
3. *Sleep onset latency* measured the number of minutes it took for the subject to fall asleep after lying down in bed.
4. *Latency to persistent sleep* referred to the number of minutes from the time the subject went to bed to the start of the first

continuous block of at least 20 min of sleep with no more than -minute of wakefulness intervening.

5. *Activity index* (%) measured the proportion of minutes during time in bed where the activity score was greater than zero. A high activity score is indicative of restlessness.
6. *Wake after sleep onset (WASO)* was defined as the number of minutes a participant was awake after the first onset of persistent sleep.
7. *Wake episodes* was the number of awakenings during time in bed.
8. *Sleep fragmentation index* was the ratio of the number of awakenings to the total sleep time in minutes (during time in bed). Higher values are indicative of restlessness or nocturnal movement.
9. *Sleep episodes* was the number of episodes of continuous sleep during time in bed. It is the count of the number of times the subject was continuously asleep (even for 1 min) during time in bed.

2.4. Covariates

Demographic characteristics, lifestyle behaviors, medical history and medication use were obtained from all participants through self- and interviewer-administered questionnaires. Body mass index (BMI) was calculated as weight (in kilograms) divided by height (in meters) squared. Waist circumference was obtained from the average of three measurements that were within 0.5 cm of each other. Blood pressure was determined using the average of the second and third of three separate measurements of resting systolic and diastolic blood pressure obtained with a standard sphygmomanometer. Hypertension was defined as a systolic blood pressure of ≥140 mm Hg or a diastolic blood pressure of ≥80 Hg mm or use of antihypertensive medications. Glucose, triglycerides, and total cholesterol were measured from blood samples using standard protocols. Social support was assessed from responses to The Social Support Scale which contained 24 questions about current relationships with friends, family members, co-workers, and community members [28].

Depressive symptoms were measured using the Center for Epidemiologic Studies in Depression (CES-D) scale. The CES-D is a short questionnaire of 20 items that was designed to measure symptoms of depression in the general population with higher scores indicating more severe depressive symptoms [29]. Participants also completed the Perceived Stress Scale which contained 14 questions about their feelings and perceptions of various events that occurred during the previous month. The scores were summed to produce a perceived stress score [30].

2.5. Statistical analyses

Descriptive statistics of the variables were obtained for all participants, women, and men using the chi-square test of independence for categorical variables and Student's *t* test for continuous variables. The prevalence of ACEs was obtained for all participants and compared between women and men using the chi-square test. For the main associations between ACEs and sleep measures, we dichotomized the number of ACEs (0 and ≥1) and used analysis of variance (ANOVA) and analysis of covariance (ANCOVA) to obtain the mean values and standard deviations (SD) or standard errors (SE) of the sleep parameters between the two ACE groups. The dichotomized version of ACEs was chosen because the cumulative score does not vary enough to capture or see a meaningful change in the sleep measures. Nearly 87% of the participants had a score ≤3 so there is not sufficient variance in the cumulative score and a regression approach that uses this score (range = 0 to 10) may not be the most appropriate strategy in this case. In addition, as opposed to the cumulative score, the binary version clearly delineates the reference group (ie, those reporting no adverse childhood experiences) for easy comparison.

The sleep efficiency variable was log-transformed due to its nonnormal distribution and the results were back-transformed for reporting (means and 95% confidence intervals (CI)). Additional analysis was conducted by comparing mean values of the sleep measures between responses (yes vs. no) from selected individual ACE items.

Effect modification was assessed for sex, race/ethnicity, and social support. Associations of selected variables with ACE scores and all sleep measures were obtained using the Pearson's correlation coefficients (for continuous variables) and ANOVA (for categorical variables). Confounders were selected based on their significant associations with both the independent (ACEs) and dependent (sleep measures) variables and/or if these variables had been confounders in previous studies. Confounders included age, sex, and race/ethnicity. To test the robustness of our results, we also adjusted for covariates that were significantly associated with sleep measures but not with ACEs. These include hypertension, triglycerides, BMI, waist circumference, depressive symptoms, perceived stress, and workload. Statistical significance was indicated if the p-value was <0.05. All analyses were conducted in SAS v. 9.4 (SAS Institute, Cary, NC, USA).

3. Results

Descriptive statistics for the participants are presented in Table 1. Participants had a mean (±SD) age of 49.4 ± 10.0 years, 29.1% were female, 81.6% were White/Hispanic, and 49.0% were patrol officers. The mean ACE score for all participants was 1.5 ± 1.8 (range = 0–8) and women had a significantly higher mean ACE score than men (2.1 ± 2.2 vs. 1.3 ± 1.5; p = 0.007). Thirty-eight percent reported that they experienced no ACEs, 24.3% reported 1 ACE, 24.8% reported 2–3 ACEs, and 12.6% reported ≥4 ACEs. Women reported higher frequencies of two or more ACEs compared to men (48.4% vs. 32.9%; p = 0.037). ACE score was positively correlated with depressive symptoms (correlation coefficient = 0.331, p < 0.0001) and perceived stress score (0.283, p < 0.0001) (data not shown).

Mean self-reported sleep duration was 6.2 ± 1.3 h while mean sleep duration as measured by actigraphy was 6.6 ± 1.0 h (Table 1). Several measures of objective sleep were significantly different between the sexes. Objective sleep duration was significantly higher in women compared to men (6.9 ± 0.89 vs. 6.5 ± 1.1 h; p = 0.004). Compared to men, women fared better with a lower mean activity index (30.0 ± 8.7 vs. 36.6 ± 11.6; <0.0001), a lower mean number of wake episodes (9.7 ± 4.1 vs. 11.4 ± 4.7; 0.017), a lower mean sleep fragmentation index (3.1 ± 1.2 vs. 3.8 ± 1.6; <0.001), and a lower mean number of sleep episodes (11.4 ± 4.3 vs. 13.1 ± 4.9; p = 0.019).

Table 2 presents prevalence of ACEs. The prevalence of positive responses to the questions (ie, adverse experiences) varied considerably across the 10 items ranging from 1% (item #5) to 38% (item #6). Compared to men, higher percentages of women answered ‘yes’ to nine of the ten ACE questions and for six of those questions (items # 3, 4, 7, 8, 9, 10) the prevalence in women was significantly higher than in men. A significantly higher percentage of women reported childhood sexual abuse compared to men (15.0% vs. 2.7%; p = 0.002). Compared to men, a higher percentage of women reported feeling unloved (18.3% vs. 6.2%; p = 0.007); experiencing childhood physical abuse (16.7% vs. 6.2%; p = 0.018); parental drug use (25.0% vs. 18.5%; p = 0.029); parental mental

Table 1
Descriptive statistics of the study sample; 2015–2019.

	All (n = 206)	Women (n = 60)	Men (n = 146)	p-value
	Mean ± SD	Mean ± SD	Mean ± SD	
Age (years) (range = 27–78)	49.4 ± 10.0	48.6 ± 9.7	49.7 ± 10.1	0.444
Years of service	20.5 ± 9.0	19.2 ± 9.0	21.0 ± 8.9	0.200
Physical activity (h/wk)	11.4 ± 10.8	8.7 ± 6.8	12.5 ± 11.9	0.005
Alcohol intake	4.8 ± 8.7	2.6 ± 4.3	5.6 ± 9.8	0.003
Systolic blood pressure (mmHg)	116.2 ± 12.4	112.9 ± 13.8	117.5 ± 11.5	0.015
Diastolic blood pressure (mmHg)	77.2 ± 9.2	73.2 ± 8.9	78.8 ± 8.5	<0.0001
Triglyceride (mg/dL)	117.0 ± 66.3	88.6 ± 48.8	128.7 ± 69.1	<0.0001
Total cholesterol (mg/dL)	194.4 ± 37.9	193.5 ± 39.2	194.8 ± 37.5	0.830
Waist circumference (cm)	98.7 ± 13.6	87.3 ± 12.1	103.3 ± 11.3	<0.0001
Self-reported sleep duration (h/day)	6.2 ± 1.3	6.3 ± 1.2	6.1 ± 1.2	0.334
Sleep measures from actigraphy				
Time in bed (h)	7.5 ± 0.95	7.7 ± 0.86	7.4 ± 0.96	0.014
Sleep duration (h)	6.6 ± 1.0	6.9 ± 0.89	6.5 ± 1.0	0.004
Sleep efficiency (%)[a]	89.3 (88.6–89.3)	90.3 (88.2–91.3)	88.9 (88.0–89.7)	0.055
Sleep onset latency (min)	6.3 ± 2.7	6.2 ± 2.7	6.3 ± 2.8	0.838
Latency to persistent sleep (min)	14.7 ± 11.1	13.9 ± 6.5	15.0 ± 12.5	0.399
Activity index (%)	34.7 ± 11.2	30.0 ± 8.7	36.6 ± 11.6	<0.0001
Wake after sleep onset (WASO) (min)	40.8 ± 24.7	37.5 ± 18.1	42.1 ± 26.9	0.150
Number of wake episodes	10.9 ± 4.6	9.7 ± 4.1	11.4 ± 4.7	0.017
Sleep fragmentation index	3.6 ± 1.5	3.1 ± 1.2	3.8 ± 1.6	<0.001
Number of sleep episodes	12.6 ± 4.8	11.4 ± 4.3	13.1 ± 4.9	0.019
Social support	85.4 ± 8.7	84.4 ± 9.6	85.9 ± 8.2	0.254
Depressive symptoms (CESD)	6.3 ± 5.9	6.9 ± 6.6	6.1 ± 5.6	0.363
Perceived stress score	16.7 ± 7.1	17.0 ± 6.9	16.6 ± 7.3	0.742
ACE score (range = 0–8)	1.5 ± 1.8	2.1 ± 2.2	1.3 ± 1.5	0.007
	N (%)	N (%)	N (%)	
Race/ethnicity				0.051
White/Hispanic	168 (81.6)	44 (73.3)	124 (84.9)	
African American	38 (18.5)	16 (26.7)	22 (15.1)	
Rank				0.920
Patrol officer	101 (49.0)	30 (50.00)	71 (48.6)	
Sergeant/Lieut/Capt	53 (25.7)	16 (26.7)	37 (25.3)	
Det/Exec/Other	52 (25.2)	14 (23.3)	38 (26.0)	
BMI (kg/m^2)				<0.0001
Normal (<25.0)	27 (13.1)	21 (35.0)	6 (4.1)	
Overweight (25–29)	93 (45.2)	23 (38.3)	70 (48.0)	
Obese (≥30)	86 (41.8)	16 (26.7)	70 (48.0)	
Smoking status				0.164
Current	11 (5.3)	4 (6.7)	7 (4.8)	
Former	55 (26.7)	21 (35.0)	34 (23.3)	
Never	140 (68.0)	35 (58.3)	105 (71.9)	
Sleep quality (PSQI)				0.046
Good (≤5)	42 (20.4)	7 (11.7)	35 (24.0)	
Poor (>5)	164 (79.6)	53 (88.3)	111 (76.0)	
Hypertension				0.012
No	146 (70.9)	50 (83.3)	96 (65.8)	
Yes	60 (29.1)	10 (16.7)	50 (34.3)	
Shiftwork (entire career)				<0.0001
Day	97 (47.3)	42 (70.0)	55 (37.9)	
Afternoon	69 (33.7)	9 (15.0)	60 (41.4)	
Night	39 (19.0)	9 (15.0)	30 (20.7)	
Workload				0.005
High	131 (63.9)	29 (49.2)	102 (69.9)	
Low/Med	74 (36.1)	30 (50.9)	44 (30.1)	
ACEs				0.049
0	79 (38.4)	17 (28.3)	62 (42.5)	
1	50 (24.3)	14 (23.3)	36 (24.7)	
2–3	51 (24.8)	16 (26.7)	35 (24.0)	
≥4	26 (12.6)	13 (21.7)	13 (8.9)	

Results were obtained from the Student's t-test (continuous variables) and the Chi-square test (categorical variables).
[a] Results for sleep efficiency are means (95% CI).

illness (26.7% vs. 12.3%; p = 0.012); and parental incarceration (11.7% vs. 2.7%; p = 0.016).

Table 3 shows associations of ACEs with self-reported sleep duration and objective measures of sleep from actigraphy among all participants. The mean self-reported sleep duration was significantly lower among participants who reported ≥1 ACEs compared to those who reported no ACEs (6.0 ± 0.11 vs. 6.4 ± 0.14 h; multivariate-adjusted p = 0.035). Objective sleep duration was not significantly associated with ACEs. Sleep efficiency was significantly better among participants who reported no ACEs (mean = 90.2%, 95% CI = 89.2–91.2) compared to those who reported ≥1 ACEs (88.7%, 87.7–89.6; unadjusted p = 0.031). These associations remained statistically significant after adjusting for age but was slightly attenuated after further adjustment for hypertension,

Table 2
Prevalence of Adverse Childhood Experiences (ACEs) among police officers.

Adverse Childhood Experiences (ACEs)	All (n = 206)	Women (n = 60)	Men (n = 146)	p
	N (%)	N (%)	N (%)	
1. 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?	45 (21.8)	18 (30.0)	27 (18.5)	0.069
2. 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?	45 (21.8)	14 (23.3)	31 (21.2)	0.740
3. 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?	13 (6.3)	9 (15.0)	4 (2.7)	0.002
4. 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?	20 (9.7)	11 (18.3)	9 (6.2)	0.007
5. 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 to take you to the doctor if you needed it?	2 (1.0)	0 (0)	2 (1.4)	1.000
6. Were your parents ever separated or divorced?	78 (37.9)	26 (43.3)	52 (35.6)	0.300
7. 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?	19 (9.2)	10 (16.7)	9 (6.2)	0.018
8. Did you live with anyone who was a problem drinker or alcoholic or used street drugs?	42 (20.4)	15 (25.0)	27 (18.5)	0.029
9. Was a household member depressed or mentally ill, or did a household member attempt suicide?	34 (16.5)	16 (26.7)	18 (12.3)	0.012
10. Did a household member go to prison?	11 (5.3)	7 (11.7)	4 (2.7)	0.016

Results were obtained from chi-square or Fisher's Exact test.

triglycerides, BMI, waist circumference, depressive symptoms, perceived stress, and workload (90.1%, 88.9–91.1 vs. 88.8%, 87.8–89.7; p = 0.094).

Participants who reported ≥1 ACEs had a higher mean activity index score (mean = 36.0 ± 11.9) compared to those who reported no ACEs (32.5 ± 9.7); p = 0.028 (Table 3). After full adjustment for confounders, the difference in the mean values between the two ACE groups was even more pronounced (0 ACE = 31.2 ± 1.25 vs. ≥1 ACEs = 36.9 ± 0.96; p = 0.001). We also found significant associations between ACEs and WASO. In the fully adjusted model, participants who reported ≥1 ACEs had a higher mean WASO of 44.3 ± 2.24 min whereas those who reported no ACEs had a mean WASO of 35.3 ± 2.92 min; p = 0.019. Sleep fragmentation index was significantly higher among participants who reported ≥1 ACEs compared to those who reported none before adjustment (p = 0.044) and just slightly attenuated after multivariate adjustment (3.8 ± 0.13 vs. 3.3 ± 0.18; p = 0.062). None of the other sleep measures (ie, sleep onset latency, latency to persistent sleep, number of wake episodes, and number of sleep episodes) was significantly associated with ACEs.

The sex-stratified results showed a few differences in the associations between ACEs and sleep measures among women and men (Table 4). The mean self-reported sleep duration was significantly lower among men (but not among women) who reported ≥1 ACEs compared to those who reported no ACEs (multivariate model: 5.9 ± 0.13 vs. 6.4 ± 0.15 h; p = 0.025). Men who reported ≥1 ACEs showed a lower mean sleep efficiency score compared to those who report no ACEs (age-adjusted model: 88.0%, 86.7–89.2 vs. 89.9%, 88.6–91.1; p = 0.038). This association was attenuated after multivariate adjustment (88.4%, 87.1–89.5 vs. 89.4%, 87.9–90.7; p = 0.293). Also, men who reported ≥1 ACEs showed a significantly higher mean activity index compared to those who report no ACEs (multivariate adjusted: 39.1 ± 1.3 vs. 33.2 ± 1.51; p = 0.004). After adjustment for age but not in the multivariate-adjusted models, men who reported ≥1 ACEs showed a higher mean WASO (46.6 ± 2.9 vs. 36.1 ± 3.4; p = 0.020) and a higher mean sleep fragmentation index (4.1 ± 0.17 vs. 3.5 ± 0.20; p = 0.021) compared to those who reported no ACEs. Both associations were slightly attenuated after multivariate adjustment. None of the associations between ACEs and sleep measures were statistically significant among women. Sex, race/ethnicity, and social support did not significantly modify the relationship between ACEs and any of the sleep measures.

Table 5 shows associations between selected questions of ACEs (rather than the total ACE score) and the sleep measures that showed significant relationships among all participants in Table 3. Compared to participants who did not report experiencing these events, participants were found to have a shorter mean sleep duration if they reported yes to question #1 (*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?*) (6.3 ± 0.15 vs. 6.7 ± 0.08 h; multivariate adjusted p = 0.047) and to question #2 (*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?*) (6.2 ± 0.15 vs. 6.7 ± 0.08 h; multivariate adjusted p = 0.007).

Three objective sleep measures showed significant associations with Question #8 (*Did you live with anyone who was a problem drinker or alcoholic or used street drugs?*) (Table 5). Compared to those who did not report experiencing this exposure, participants who reported yes to question #8 had a lower (ie, worse) mean sleep efficiency (87.6, 85.7–89.2 vs. 89.7, 88.9–90.4; multivariate adjusted p = 0.026). None of the other individual questions was significantly associated with sleep efficiency. Participants who reported yes to question #8 also had a higher (ie, worse) mean activity index (37.7 ± 1.7 vs. 34.0 ± 0.85; multivariate adjusted p = 0.049) and a higher (ie, worse) mean number of minutes of WASO (50.2 ± 3.9 vs. 38.4 ± 1.9 min; multivariate adjusted p = 0.008) compared to those who did not report experiencing this exposure.

4. Discussion

In this study, we sought to investigate cross-sectional associations between ACEs and several measures of sleep quantity and

Table 3
Associations between ACEs and sleep measures from self-report and actigraphy among all officers; BCOPS 2015–2019.

	Model 1	Model 2	Model 3
	Mean ± SD	Mean ± SE	Mean ± SE
Self-reported sleep duration (h)			
ACEs			
0	6.5 ± 1.18	6.5 ± 0.14	6.4 ± 0.14
≥1	6.0 ± 1.23	6.0 ± 0.11	6.0 ± 0.11
p-value	0.003	0.002	0.035
Objective sleep duration (h)			
ACEs			
0	6.7 ± 0.98	6.7 ± 0.12	6.6 ± 0.12
≥1	6.5 ± 1.06	6.5 ± 0.09	6.6 ± 0.09
p-value	0.322	0.287	0.577
Sleep efficiency (%)[a]			
ACEs			
0	90.2 (89.2–91.2)	90.2 (89.2–91.2)	90.1 (88.9–91.1)
≥1	88.7 (87.7–89.6)	88.7 (87.7–89.6)	88.8 (87.8–89.7)
p-value	0.031	0.036	0.094
Sleep onset latency (min)			
ACEs			
0	6.3 ± 2.85	6.4 ± 0.30	6.5 ± 0.32
≥1	6.3 ± 2.65	6.2 ± 0.24	6.3 ± 0.25
p-value	0.982	0.591	0.607
Latency to persistent sleep (min)			
ACEs			
0	14.2 ± 8.0	14.2 ± 1.26	14.2 ± 1.34
≥1	15.0 ± 12.7	15.0 ± 0.99	15.1 ± 1.03
p-value	0.641	0.636	0.599
Activity index (%)			
ACEs			
0	32.5 ± 9.7	32.2 ± 1.25	31.2 ± 1.25
≥1	36.0 ± 11.9	36.2 ± 0.98	36.9 ± 0.96
p-value	0.028	0.014	0.001
Wake after sleep onset (WASO) (min)			
ACEs			
0	35.5 ± 17.5	35.2 ± 2.76	35.3 ± 2.92
≥1	44.0 ± 27.8	44.2 ± 2.17	44.3 ± 2.24
p-value	0.015	0.011	0.019
Number of wake episodes			
ACEs			
0	10.2 ± 4.4	10.3 ± 0.52	10.2 ± 0.55
≥1	11.3 ± 4.7	11.2 ± 0.41	11.3 ± 0.42
p-value	0.112	0.167	0.147
Sleep fragmentation index			
ACEs			
0	3.3 ± 1.20	3.4 ± 0.17	3.3 ± 0.18
≥1	3.8 ± 1.65	3.8 ± 0.13	3.8 ± 0.13
p-value	0.044	0.053	0.062
Number of sleep episodes			
ACEs			
0	11.9 ± 4.6	12.0 ± 0.54	11.9 ± 0.57
≥1	13.0 ± 4.9	12.9 ± 0.43	13.0 ± 0.44
p-value	0.124	0.169	0.157

[a] Results for sleep efficiency are means (95% CI). Results obtained from ANOVA and ANCOVA.
Model 1: Unadjusted.
Model 2: Adjusted for age.
Model 3: Adjusted for age, sex, race/ethnicity, hypertension, triglycerides, BMI, waist circumference, depressive symptoms, perceived stress, workload.

quality among police officers. Our results showed that participants who were exposed to ≥1 ACEs had significantly shorter self-reported sleep duration compared to those who reported no ACE exposure. Interestingly, this association was not significant when sleep duration was assessed by actigraphy. Results also showed that, compared to no ACE exposure, exposure to ≥1 ACEs was significantly associated with, on average, a lower sleep efficiency, a higher activity index score, and a higher number of wakes after sleep onset. ACEs were not significantly associated with any of the other sleep measures (ie, sleep onset latency, latency to persistent sleep, number of wake episodes, sleep fragmentation index, and number of sleep episodes). When these associations were stratified by sex, significant associations were observed between a few ACEs and sleep measures, but only among men. Compared to male participants who reported no ACE exposure, men who reported past exposure to ≥1 ACEs had, on average, a shorter self-reported sleep duration, a lower sleep efficiency, a significantly higher activity index, a higher number of wakes after sleep onset, and a higher sleep fragmentation index. No significant associations were observed between ACEs and sleep measures among women.

The findings of this current study are consistent with those of several studies even though the participants, sample sizes, length of the ACE questionnaire, and other factors may have differed. In a systematic review article, approximately 90% of the retrospective studies reported statistically significant associations between various sleep disorders among persons with a history of childhood adversity [31]. In many of these studies, the strength of associations increased with the number and severity of adverse experiences. In a study investigating persons in a low-income community, persons who had experienced ACEs were more likely to have heightened stress levels and sleep disturbances compared to those who had not experienced ACEs [32].

In another study, 9.8% of 8184 participants reported childhood sexual abuse and childhood sexual abuse significantly predicted insomnia symptoms among women decades after abuse [33]. The authors also found that exposure to more than one perpetrator and feeling forced/threatened increased sleep risk. Sheehan and colleagues (2020) investigated associations of the quantity, timing, and type of childhood adversity with subjective and actigraphic sleep measures among 863 U.S. adults (25–76 years) who had participated in the Biomarker Project in the Midlife in the United States Refresher study [7]. This study included several distinct types of adverse childhood events. The authors observed that childhood adversity was related to worse subjective and actigraphic sleep measures (except for total sleep duration) after controlling for age, sex, and race. Exposure to more adverse events, particularly three or more events, or adverse events during both childhood and adolescence, was associated with worse self-reported sleep and actigraphic sleep, including longer sleep-onset latency, sleep efficiency, and longer WASO. A study conducted on 22,403 adults using data from the 2011 Behavioral Risk Factor Surveillance System found that short sleep duration (<6 h/night) was positively and significantly associated with the number of ACEs [8]. Each individual adverse experience was associated with higher odds of short sleep duration, with physical abuse (ie, parents hitting each other, parents hitting children, and rape) having the strongest likelihood. This association was observed for each decade of age until the 60s, although the magnitude attenuated with age. Baiden and colleagues (2015) examined the association between early childhood adversities and troubled sleep among 19,349 adult Canadians using the Canadian Community Health Survey – Mental Health (CCHS-MH) [34]. For each additional childhood adversity experienced, the odds of having sleep problems such as insomnia or disordered breathing while sleep increased by 10% after controlling for socio-demographic, socioeconomic, health, and mental health factors. These results also revealed that more severe and chronic types of childhood adversities, such as sexual, physical, and multiple types of abuse, had the largest associations with sleep problems.

In the current study, investigation of the individual ACE questions revealed that positive responses to Question #8 (*Did you live with anyone who was a problem drinker or alcoholic or used street drugs?*) was associated with reduced sleep continuity. Exposure to this ACE event was associated with, on average, a lower sleep efficiency, a higher activity index, and a higher WASO. Positive responses to both ACE questions #1 (*Did a parent or other adult in the household often or very often swear at you, insult you, put you down,*

Table 4
Associations between ACEs and sleep measures from self-report and actigraphy among women and men; BCOPS 2015–2019.

	Women			Men		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	Mean ± SD	Mean ± SE	Mean ± SE	Mean ± SD	Mean ± SE	Mean ± SE
Self-reported sleep duration (h)						
ACEs						
0	6.3 ± 1.13	6.3 ± 0.30	6.4 ± 0.33	6.6 ± 1.20	6.6 ± 0.15	6.4 ± 0.15
≥1	6.3 ± 1.27	6.3 ± 0.19	6.2 ± 0.20	5.8 ± 1.19	5.8 ± 0.13	5.9 ± 0.13
p-value	0.982	0.934	0.542	<0.001	<0.001	0.025
Objective sleep duration (h)						
ACEs						
0	6.8 ± 0.92	6.9 ± 0.22	7.0 ± 0.22	6.6 ± 1.00	6.6 ± 0.13	6.5 ± 0.14
≥1	7.0 ± 0.89	6.9 ± 0.14	6.9 ± 0.14	6.3 ± 1.08	6.3 ± 0.12	6.4 ± 0.11
p-value	0.659	0.758	0.832	0.074	0.078	0.715
Sleep efficiency (%)[a]						
ACEs						
0	91.3 (89.3–92.9)	91.2 (89.2–92.9)	91.8 (89.8–93.4)	91.3 (89.3–92.9)	89.9 (88.6–91.1)	89.4 (87.9–90.7)
≥1	89.9 (88.6–91.1)	89.9 (88.6–91.2)	89.7 (88.2–91.0)	89.9 (88.6–91.1)	88.0 (86.7–89.2)	88.4 (87.1–89.5)
p-value	0.248	0.263	0.094	0.032	0.038	0.293
Sleep onset latency (min)						
ACEs						
0	5.8 ± 2.5	5.9 ± 0.64	5.8 ± 0.69	6.4 ± 3.0	6.6 ± 0.34	6.7 ± 0.37
≥1	6.4 ± 2.7	6.4 ± 0.40	6.5 ± 0.42	6.2 ± 2.6	6.1 ± 0.29	6.1 ± 0.31
p-value	0.398	0.503	0.381	0.638	0.341	0.221
Latency to persistent sleep (min)						
ACEs						
0	12.9 ± 5.2	12.5 ± 1.5	11.5 ± 1.5	14.6 ± 8.7	14.7 ± 1.6	14.8 ± 1.7
≥1	14.3 ± 6.9	14.4 ± 0.95	14.9 ± 0.94	15.3 ± 14.8	15.2 ± 1.4	15.3 ± 1.4
p-value	0.449	0.294	0.077	0.732	0.809	0.834
Activity index (%)						
ACEs						
0	27.6 ± 9.1	27.7 ± 2.1	26.5 ± 2.2	33.9 ± 9.5	33.5 ± 1.4	33.2 ± 1.5
≥1	31.0 ± 8.5	31.0 ± 1.3	31.6 ± 1.3	38.6 ± 12.5	38.9 ± 1.2	39.1 ± 1.3
p-value	0.172	0.196	0.059	0.014	0.005	0.004
Wake after sleep onset (WASO) (min)						
ACEs						
0	31.8 ± 15.5	32.0 ± 4.4	29.5 ± 4.7	36.5 ± 18.0	36.1 ± 3.4	37.3 ± 3.6
≥1	39.7 ± 18.7	39.6 ± 2.8	40.6 ± 2.9	46.3 ± 31.3	46.6 ± 2.9	45.9 ± 3.0
p-value	0.128	0.149	0.059	0.030	0.020	0.077
Number of wake episodes						
ACEs						
0	9.0 ± 4.6	9.1 ± 1.0	8.8 ± 1.1	10.6 ± 4.4	10.6 ± 0.60	10.7 ± 0.64
≥1	9.9 ± 3.9	9.9 ± 0.63	10.0 ± 0.66	11.9 ± 4.9	11.9 ± 0.51	11.8 ± 0.53
p-value	0.427	0.489	0.368	0.078	0.115	0.198
Sleep fragmentation index						
ACEs						
0	2.9 ± 1.1	2.9 ± 0.29	2.7 ± 0.32	3.5 ± 1.2	3.5 ± 0.20	3.6 ± 0.21
≥1	3.1 ± 1.3	3.1 ± 0.18	3.2 ± 0.20	4.1 ± 1.7	4.1 ± 0.17	4.0 ± 0.18
p-value	0.445	0.453	0.202	0.016	0.021	0.138
Number of sleep episodes						
ACEs						
0	10.7 ± 4.8	10.7 ± 1.1	10.4 ± 1.1	12.3 ± 4.5	12.3 ± 0.62	12.4 ± 0.66
≥1	11.6 ± 4.2	11.6 ± 0.67	11.7 ± 0.70	13.7 ± 5.1	13.6 ± 0.53	13.6 ± 0.55
p-value	0.456	0.489	0.351	0.085	0.121	0.206

[a] Results for sleep efficiency are means (95% CI). Results obtained from ANOVA and ANCOVA.
Model 1: Unadjusted.
Model 2: Adjusted for age.
Model 3: Adjusted for age, race/ethnicity, hypertension, triglycerides, BMI, waist circumference, depressive symptoms, perceived stress, workload.

or humiliate you? Or act in a way that made you afraid that you might be physically hurt?) and #2 (*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?*) were significantly associated with shorter self-reported sleep duration. Other ACE questions were not associated with sleep measures. Questions on childhood neglect (question #4), poverty (#5), divorce (#6), parental mental illness (#9), and parental incarceration (#10) were not observed to be significantly associated with shorter sleep duration, sleep efficiency, activity index, or WASO. Although some of these findings may have resulted from reduced statistical power, other factors which are not entirely clear may also be responsible. This is a topic that warrants future investigation.

The associations observed between ACEs and sleep measures may occur through several mechanisms. These individuals who are exposed to ACEs may be exposed to other adverse events inside or outside their homes, may adopt poor strategies to deal with their trauma that exacerbate their already vulnerable conditions, or may become hyper-aroused when confronted with acute stressors in adulthood [35]. Any one or a combination of these and other factors can also negatively affect sleep quality.

Table 5
Associations between selected items of ACE, self-reported sleep duration, sleep efficiency, activity index, and wake after sleep onset (WASO).

	Model 1	Model 2
	Mean ± SE	Mean ± SE
Self-reported sleep duration (h)		
1. 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?		
No	6.6 ± 0.08	6.7 ± 0.08
Yes	6.4 ± 0.15	6.3 ± 0.15
p-value	0.223	0.047
2. 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?		
No	6.7 ± 0.08	6.7 ± 0.08
Yes	6.3 ± 0.15	6.2 ± 0.15
p-value	0.011	0.007
8. Did you live with anyone who was a problem drinker or alcoholic or used street drugs?		
No	6.7 ± 0.08	6.7 ± 0.08
Yes	6.3 ± 0.16	6.3 ± 0.15
p-value	0.065	0.063
	Mean (95% CI)	Mean (95% CI)
Sleep efficiency (%)		
2. 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?		
No	89.7 (88.9–90.4)	89.6 (88.8–90.3)
Yes	88.0 (86.2–89.6)	88.2 (86.4–89.7)
p-value	0.063	0.124
8. Did you live with anyone who was a problem drinker or alcoholic or used street drugs?		
No	89.7 (88.9–90.4)	89.7 (88.9–90.4)
Yes	87.7 (85.8–89.3)	87.6 (85.7–89.2)
p-value	0.029	0.026
	Mean ± SE	Mean ± SE
Activity index (%)		
8. Did you live with anyone who was a problem drinker or alcoholic or used street drugs?		
No	34.1 ± 0.87	34.0 ± 0.85
Yes	37.1 ± 1.72	37.7 ± 1.69
p-value	0.114	0.049
Wake after sleep onset (WASO) (min)		
8. Did you live with anyone who was a problem drinker or alcoholic or used street drugs?		
No	38.4 ± 1.90	38.4 ± 1.93
Yes	50.0 ± 3.76	50.2 ± 3.85
p-value	0.007	0.008

Results obtained from ANOVA and ANCOVA.
Model 1: Age-adjusted.
Model 2: Adjusted for age, sex, race/ethnicity, hypertension, triglycerides, BMI, waist circumference, depressive symptoms, perceived stress, and workload.

Data from the National Sleep Foundation's 2020 Sleep in America poll show that poor sleep can impact mood (58%), cause occasional irritability (55%), headaches (36%), and a general feeling of being unwell (33%) [23]. For participants who might be experiencing sleep disorders, there are strategies that can be adopted to mitigate these problems. Social support from family and friends has been shown to decrease trauma symptoms among both women and men [36,37]. Other strategies that are increasingly commonly used and found to be effective are emotional freedom technique (also known as tapping) [38], mindfulness meditation [39,40], and improved sleep hygiene [41].

4.1. Limitations and strengths

There are several limitations of this study which are worth mentioning. The first limitation is the cross-sectional study design which precluded us from making causal inferences. Another limitation is that of possible reporting bias which could have limited our ability to detect significant associations. If some participants had underreported their ACEs, the associations we observed may have been biased towards the null. Gaensbauer and Jordan (2009) mentioned that recall bias may be possible especially if trauma occurred before the age of 4 years [35]. Also, the relatively small sample size prevented us from stratifying the main associations on other variables while being confident of sufficient power to detect associations.

Another limitation is that the ACE questionnaire used in the current study contains 10 questions which may not have been sufficiently comprehensive in capturing the full extent of trauma experienced during childhood. In a recent study, the authors explained how a revised questionnaire that captures additional experiences would be more appropriate for 21st century research [42]. They examined whether the items from the original Adverse Childhood Experiences (ACEs) Scale can be improved to predict health outcomes more accurately by adding some additional widely recognized childhood adversities. Their results showed that there are other childhood adversities, besides those included in the original ACE Scale, that are important predictors of physical and mental health problems in adulthood. These predictors include peer victimization, isolation and peer rejection, exposure to community violence, and low socioeconomic status. Peer victimization and the other maltreatment variables, emotional abuse, physical abuse, and sexual assault, were significant in predicting distress but not health status. The questionnaire used in the current study may have caused us to miss some important associations with sleep quantity and/or quality.

Another limitation is that pertinent information such as the timing of the ACE exposure, for example whether the ACEs occurred during childhood or adolescence, was not collected. Also, no information was collected on the duration of abuse, relationship to abuser, whether the participants felt threatened by the abuser, or additional traumatic events that occurred in adulthood. Absence of such variables may have affected our ability to obtain stronger or different associations between ACEs and the sleep measures. Previous research has shown that the timing of childhood adversity may be important as exposure to adverse events during critical or sensitive periods of life may be especially harmful and predictive for more severe chronic disease and other health outcomes in adulthood [43]. Steine and colleagues (2012) reported that a younger age at the time of assessment, longer lasting abuse, as well as having experienced being threatened by the perpetrator, was associated with higher nightmare frequency [44].

There are a few strengths to this study which are worth mentioning. To the best of our knowledge, this is the first study on the topic of ACEs and sleep measures among police officers. Whereas several studies on ACEs and sleep used self-reported measures of sleep duration and quality, we were able to use objective measures of sleep from actigraphy.

5. Conclusions

Results of this study showed that exposure to ACEs are associated with shorter sleep duration and worse sleep quality during adulthood among police officers. These results may be underestimated. Although a significant difference in sleep efficiency was observed between those who experienced ACEs and those who did not, the mean sleep efficiency in both groups was above what is considered "normal" (>85%) and hence caution is advised when interpreting the result.

Police officers have demanding duties which can be very stressful even when they have good quality and sufficient hours of sleep. Having less than optimum sleep increases the chances of officers not performing to the best of their ability which can increase the chances of making mistakes on the job, some of which can be fatal. Future research, which includes using a more comprehensive ACE questionnaire, collection of adverse events and lifestyle habits during adulthood, and a larger sample size, is warranted.

Data availability statement

The SAS data used to support the findings of this Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) study have not been made available because of the sensitive nature of the health-related outcomes and the potential for participant re-identification.

Ethics review and approval

All participants signed written informed consent. The Institutional Review Board at the State University of New York at Buffalo approved the studies.

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Conflict of interest

None declared.

The authors alone are responsible for the content and writing of the paper.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the National Institute for Occupational Safety and Health, Centers for Disease Control and Prevention.

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2021.12.011.

References

[1] Petruccelli K, Davis J, Berman T. Adverse childhood experiences and associated health outcomes: a systematic review and meta-analysis. Child Abuse Negl 2019;97:104127.
[2] Sahle BW, Reavley NJ, Li W, et al. The association between adverse childhood experiences and common mental disorders and suicidality: an umbrella review of systematic reviews and meta-analyses. Eur Child Adolesc Psychiatry 2021. https://doi.org/10.1007/s00787-021-01745-2. PMID: 33638709. [Online ahead of print].
[3] Lietzen R, Suominen S, Sillanmaki L, et al. Multiple adverse childhood experiences and asthma onset in adulthood: role of adulthood risk factors as mediators. J Psychosom Res 2021;143:110388.
[4] Dube SR, Fairweather D, Pearson WS, et al. Cumulative childhood stress and autoimmune diseases in adults. Psychosom Med 2009;71:243–50.
[5] Santoro AF, Suchday S, Robbins RN, et al. Childhood adversity and physical health among Asian Indian emerging adults in the United States: exploring disease-specific vulnerabilities and the role of anger. Psychol Trauma 2021;13:214–22.
[6] Beilharz JE, Paterson M, Fatt S, et al. The impact of childhood trauma on psychosocial functioning and physical health in a non-clinical community sample of young adults. Aust N Z J Psychiatry 2020;54:185–94.
[7] Sheehan CM, Li L, Friedman EM. Quantity, timing, and type of childhood adversity and sleep quality in adulthood. Sleep Health 2020;6:246–52.
[8] Sullivan K, Rochani H, Huang LT, et al. Adverse childhood experiences affect sleep duration for up to 50 years later. Sleep 2019;42.
[9] Nissen C, Piosczyk H, Holz J, et al. Sleep is more than rest for plasticity in the human cortex. Sleep 2021:44.
[10] Grandner MA. Sleep, health, and society. Sleep Med Clin 2017;12:1–22.
[11] Grandner MA, Hale L, Moore M, et al. Mortality associated with short sleep duration: the evidence, the possible mechanisms, and the future. Sleep Med Rev 2010;14:191–203.
[12] Chaput JP, Bouchard C, Tremblay A. Change in sleep duration and visceral fat accumulation over 6 years in adults. Obesity (Silver Spring) 2014;22:E9–12.
[13] Watanabe M, Kikuchi H, Tanaka K, et al. Association of short sleep duration with weight gain and obesity at 1-year follow-up: a large-scale prospective study. Sleep 2010;33:161–7.
[14] Barone MT, Menna-Barreto L. Diabetes and sleep: a complex cause-and-effect relationship. Diabetes Res Clin Pract 2011;91:129–37.
[15] Zizi F, Jean-Louis G, Brown CD, et al. Sleep duration and the risk of diabetes mellitus: epidemiologic evidence and pathophysiologic insights. Curr Diab Rep 2010;10:43–7.
[16] Grandner MA, Sands-Lincoln MR, Pak VM, et al. Sleep duration, cardiovascular disease, and proinflammatory biomarkers. Nat Sci Sleep 2013;5:93–107.
[17] van Leeuwen WM, Lehto M, Karisola P, et al. Sleep restriction increases the risk of developing cardiovascular diseases by augmenting proinflammatory responses through IL-17 and CRP. PLoS One 2009;4:e4589.
[18] Grandner MA, Chakravorty S, Perlis ML, et al. Habitual sleep duration associated with self-reported and objectively determined cardiometabolic risk factors. Sleep Med 2014;15:42–50.
[19] Verweij IM, Romeijn N, Smit DJ, et al. Sleep deprivation leads to a loss of functional connectivity in frontal brain regions. BMC Neurosci 2014;15:88.
[20] Grandner MA, Jackson NJ, Izci-Balserak B, et al. Social and behavioral determinants of perceived insufficient sleep. Front Neurol 2015;6:112.
[21] Chakravorty S, Siu HY, Lalley-Chareczko L, et al. Sleep duration and insomnia symptoms as risk factors for suicidal ideation in a nationally representative sample. Prim Care Companion CNS Disord 2015;17.
[22] Liu Y, Wheaton AG, Chapman DP, et al. Prevalence of healthy sleep duration among adults–United States, 2014. MMWR Morb Mortal Wkly Rep 2016;65:137–41.
[23] Foundation NS. Sleep in America(R) Poll 2020. 2020.
[24] Violanti JM, Burchfiel CM, Miller DB, et al. The Buffalo Cardio-Metabolic Occupational Police Stress (BCOPS) pilot study: methods and participant characteristics. Ann Epidemiol 2006;16:148–56.
[25] Felitti VJ, Anda RF, Nordenberg D, et al. Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults. The Adverse Childhood Experiences (ACE) Study. Am J Prev Med 1998;14:245–58.

[26] Buysse DJ, Reynolds 3rd CF, Monk TH, et al. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. Psychiatry Res 1989;28:193–213.
[27] Knutson KL, Rathouz PJ, Yan LL, et al. Stability of the Pittsburgh Sleep Quality Index and the Epworth Sleepiness Questionnaires over 1 year in early middle-aged adults: the CARDIA study. Sleep 2006;29:1503–6.
[28] Cutrona CE, Russell DW. The provisions of social relationships and adaptation to stress. In: Jones WH, Perlman D, editors. Advances in personal relationships. Greenwich, CT: JAI Press; 1987. p. 37–67.
[29] Radloff LS. The CES-D scale: a self-report depression scale for research in the general population. Appl Psychol Meas 1977;1:385–401.
[30] Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav 1983;24:385–96.
[31] Kajeepeta S, Gelaye B, Jackson CL, et al. Adverse childhood experiences are associated with adult sleep disorders: a systematic review. Sleep Med 2015;16:320–30.
[32] Salinas-Miranda AA, Salemi JL, King LM, et al. Adverse childhood experiences and health-related quality of life in adulthood: revelations from a community needs assessment. Health Qual Life Outcomes 2015;13:123.
[33] Lind MJ, Aggen SH, Kendler KS, et al. An epidemiologic study of childhood sexual abuse and adult sleep disturbances. Psychol Trauma 2016;8:198–205.
[34] Baiden P, Fallon B, den Dunnen W, et al. The enduring effects of early-childhood adversities and troubled sleep among Canadian adults: a population-based study. Sleep Med 2015;16:760–7.
[35] Gaensbauer TJ, Jordan L. Psychoanalytic perspectives on early trauma: interviews with thirty analysts who treated an adult victim of a circumscribed trauma in early childhood. J Am Psychoanal Assoc 2009;57:947–77.
[36] Evans SE, Steel AL, DiLillo D. Child maltreatment severity and adult trauma symptoms: does perceived social support play a buffering role? Child Abuse Negl 2013;37:934–43.
[37] Steine IM, Harvey AG, Krystal JH, et al. Sleep disturbances in sexual abuse victims: a systematic review. Sleep Med Rev 2012;16:15–25.
[38] Sebastian B, Nelms J. The effectiveness of emotional freedom techniques in the treatment of posttraumatic stress disorder: a meta-analysis. Explore (NY) 2017;13:16–25.
[39] Rusch HL, Rosario M, Levison LM, et al. The effect of mindfulness meditation on sleep quality: a systematic review and meta-analysis of randomized controlled trials. Ann N Y Acad Sci 2019;1445:5–16.
[40] Wielgosz J, Goldberg SB, Kral TRA, et al. Mindfulness meditation and psychopathology. Annu Rev Clin Psychol 2019;15:285–316.
[41] Chung KF, Lee CT, Yeung WF, et al. Sleep hygiene education as a treatment of insomnia: a systematic review and meta-analysis. Fam Pract 2018;35:365–75.
[42] Finkelhor D, Shattuck A, Turner H, et al. A revised inventory of adverse childhood experiences. Child Abuse Negl 2015;48:13–21.
[43] Kuh D, Ben-Shlomo Y, Lynch J, et al. Life course epidemiology. J Epidemiol Community Health 2003;57:778–83.
[44] Steine IM, Krystal JH, Nordhus IH, et al. Insomnia, nightmare frequency, and nightmare distress in victims of sexual abuse: the role of perceived social support and abuse characteristics. J Interpers Violence 2012;27:1827–43.