Received: 18 December 2020 | Revised: 20 July 2021 | Accepted: 23 July 2021

DOI: 10.1002/jts.22752

ISTSS International Society for Traumatic Stress Studies WILEY

RESEARCH ARTICLE

Investigating the associations between childhood trauma and cardiovascular health in midlife

Billy A. Caceres[1] | **Laura E. Britton**[1] | **Yamnia I. Cortes**[2] | **Nour Makarem**[3] | **Shakira F. Suglia**[4]

[1] Columbia University School of Nursing, New York, New York, USA

[2] School of Nursing, The University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, USA

[3] Department of Epidemiology, Mailman School of Public Health, Columbia University Irving Medical Center, New York, New York, USA

[4] Rollins School of Public Health, Emory University, Atlanta, Georgia, USA

Correspondence
Dr. Billy A. Caceres, 560 West 168th, Street, Room 603, New York, NY, USA.
Email: bac2134@cumc.columbia.edu

Data used for this research were provided by the longitudinal Midlife in the United States (MIDUS) study, which is managed by the Institute on Aging at the University of Wisconsin. This research was supported by a grant from the National Institute on Aging (P01AG020166). Additional support was obtained from the National Heart, Lung, and Blood Institute (K01HL146965, K99HL148511, R00HL148511, R25HL10544); the National Institute of Nursing Research (T32NR014205, T32NR007969); and the National Institute on Minority Health and Health Disparities (K23MD014767). The authors have no conflicts of interest to disclose.

Funding information
National Institute of Nursing Research, Grant/Award Numbers: T32NR007969, T32NR014205; National Institute on Aging, Grant/Award Number: P01AG020166; National Institute on Minority Health and Health Disparities, Grant/Award Number: K23MD014767; National Heart, Lung, and Blood Institute, Grant/Award Numbers: K01HL146965, K99HL148511, R00HL148511, R25HL10544

Abstract

Growing evidence suggests that childhood trauma is associated with poorer cardiovascular health in adulthood, but few studies have examined potential mediators of these associations. We examined the links between different forms of childhood trauma (i.e., abuse, neglect, cumulative trauma) and cardiovascular health and explored potential mediators. Cross-sectional data from 1,251 participants in the National Survey of Midlife Development in the United States' II Biomarker Project were analyzed. Path analyses were conducted to examine the associations between childhood trauma and cardiovascular health (i.e., American Heart Association's Life's Simple 7 [LS7] score). Depressive symptoms and sleep quality were explored as potential mediators, and exploratory analyses examined whether these associations were moderated by sex. Women reported more severe childhood emotional and sexual abuse and emotional neglect, $p < .001$ to $p = .018$, and higher LS7 scores, $p = .027$, than men. Path analyses demonstrated the total effects of increasing severity of all forms of childhood trauma with LS7 scores were significant, and cumulative childhood trauma was inversely associated with LS7 score *B*s = -0.306– -0.076, $p < .001$–$p = .048$. The range of total effects of different forms of childhood trauma on LS7 scores mediated by depressive symptoms and sleep quality was 26.8%–57.5%. Sex moderated the associations between all forms of childhood trauma and cardiovascular health. Longitudinal studies are needed that examine mediators of the associations between childhood trauma and cardiovascular health. Findings suggest sex-specific, trauma-informed approaches for cardiovascular disease prevention in adults exposed to childhood trauma may be needed.

Cardiovascular disease (CVD) is the leading cause of death and disability worldwide (World Health Organization, 2017). Adults with a history of childhood trauma, such as emotional, physical, and sexual abuse or neglect, have been shown to have a higher prevalence of CVD (Basu et al., 2017; Fuller-Thomson et al., 2010). In a systematic review of 40 studies, Basu et al. (2017) found that 91.7% of the included studies reported significant associations between childhood trauma exposure and CVD outcomes, such as stroke. In addition, more than 88% and 60% of the included studies reported associations between diabetes and hypertension, respectively, and childhood trauma.

Childhood trauma is associated with a higher prevalence of psychosocial and behavioral factors in adulthood (Infurna et al., 2016; Liu et al., 2019; Thordardottir et al., 2016), which significantly contribute to an increased risk of CVD (O'Donnell et al., 2010; Yusuf et al., 2004). Prior evidence suggests that the association between childhood trauma and CVD may be mediated by modifiable factors, such as depression (Kahl et al., 2015; Mandelli et al., 2015; Whitworth et al., 2016) and sleep disturbances (Hoag et al., 2015; Petrov et al., 2016; Thordardottir et al., 2016). For instance, in the aforementioned systematic review, the authors found that mental health problems, such as depression, partially mediated the association between childhood trauma and CVD in adults (Basu et al., 2017). Further, findings from a recent study demonstrated that poorer sleep quality partially mediated the association between childhood trauma and hypertension in middle-aged adults (Petrov et al., 2016).

Childhood trauma is a significant public health concern in the United States, with an estimated 1 in 7 children experiencing at least one form of trauma in the past year (Centers for Disease Control & Prevention, 2021). Data from population-based studies in the United States indicate that among children, the lifetime prevalence of physical abuse by a caregiver is between 9% and12% (Finkelhor et al., 2013; Jobe-Shields et al., 2018), with boys more likely than girls to report physical abuse from a caregiver (Finkelhor et al., 2013; Thompson et al., 2004). Approximately 15% of children in the United States have experienced emotional abuse or caregiver neglect in their lifetime. The lifetime prevalence of childhood sexual abuse from any perpetrator is higher among girls compared with boys (i.e., 11% vs. 8%; Finkelhor et al., 2013).

Some findings suggest that there are sex differences not only regarding exposure to abuse but also in the association between childhood trauma and CVD risk. Several factors may contribute to these differences. Women are more likely to report exposure to lifetime sexual abuse than men (de Waal et al., 2017; Meng & D'Arcy, 2016). Further, biological factors may differentially influence the development of CVD in women. Premenopausal women tend to have lower blood pressure and glucose levels than men in the same age group; these differences may narrow as age increases or even reverse during menopause (Colafella & Denton, 2018; Dasinger & Alexander, 2016; Varlamov et al., 2014). Sex hormones play an important role in regulating biological responses to stress, which are implicated in the development of CVD (Oyola & Handa, 2017).

Existing evidence on sex differences in the association between childhood trauma and CVD risk is conflicting. Investigators have found that both men and women with a history of childhood trauma have a higher prevalence of diabetes and obesity, but only women demonstrate a significantly higher prevalence of CVD (Friedman et al., 2015). In a sample of adults with a history of psychosis, Sweeney et al. (2015) found men who experienced childhood trauma were more likely to report a history of CVD than women. In contrast, analyses of data from the National Longitudinal Study of Adolescent Health have shown that among young adults, women with a history of childhood sexual abuse have a higher prevalence of hypertension; however, this association did not emerge among men (Suglia et al., 2014). Given these conflicting findings, more research is needed to determine if sex differences exist in the association between childhood trauma and cardiovascular health (CVH).

In 2010, the American Heart Association developed the Life's Simple 7 (LS7) assessment, a measure of CVH that includes three health behaviors and four health factors and has been shown to strongly predict future CVD risk (Lloyd-Jones et al., 2010). Multiple studies have indicated that higher LS7 scores are associated with lower incident CVD (Gaye et al., 2017; Ommerborn et al., 2016), cognitive decline (Pase et al., 2016), and mortality (Fang et al., 2016; Ford et al., 2012). To date, no studies have examined the associations between childhood trauma and ideal CVH in midlife. Researchers who have examined the associations between childhood trauma and CVH have largely focused on identifying differences in the prevalence of individual CVH metrics (Abajobir et al., 2017; Basu et al., 2017; Kreatsoulas et al., 2019; Ruiz & Font, 2020).

To address these knowledge gaps, we conducted a secondary analysis of data from the National Survey of Midlife Development in the U.S. Study (MIDUS) to examine the associations between different forms of childhood trauma, including abuse and neglect, and CVH. The present investigation was informed by the model of childhood adversity and cardiometabolic health (Suglia et al., 2018). We hypothesized that more severe childhood trauma exposure would be associated with poorer CVH in midlife and that this association would be mediated by depressive symptoms and sleep quality. Given that women are more prone to childhood trauma than men, we further hypothesized that these associations would be stronger

among women; we explored this hypothesis by conducting exploratory analyses examining whether the associations between childhood trauma and CVH were moderated by sex.

METHOD

Participants

The MIDUS Study is a national longitudinal study that examines health and aging among residents of the United States. MIDUS I was conducted in 1995–1996 in the 48 contiguous states with a random digit dialing sample of 7,108 noninstitutionalized, English-speaking participants between the ages of 25 and 74 years. In 2005 a 10-year follow-up study, MIDUS II, was conducted. The present study represents a secondary analysis of the MIDUS II Biomarker Project (2004–2009, $N = 1{,}255$), a cross-sectional substudy that included two distinct samples: (a) participants from MIDUS I who participated in MIDUS II and (b) a MIDUS II subsample of Black/African American adults from Milwaukee, WI, a city in the midwestern United States. Of the 1,255 participants in the Biomarker Project, we excluded individuals with missing data for childhood trauma exposure ($n = 4$), resulting in a sample of 1,251 participants. The mean participant age in the final sample was 54.5 years ($SD = 11.71$) and 56.8% were women ($n = 710$). Most participants were White (77.5%), had more than a high school education (72.2%), and were currently employed (54.2%); 42.6% of participants reported an annual household income less than $50,000 (USD).

Procedure

The Institutional Review Boards of the University of California Los Angeles, the University of Wisconsin, and the Georgetown University in the United States approved the MIDUS II Biomarker Project, and the data are publicly available. Data collection in MIDUS II consisted of detailed self-administered questionnaires that were mailed to participants or administered via telephone. Approximately 70% of participants in the original sample ($N = 4{,}963$) participated in MIDUS II. From 2004 to 2006, a supplementary sample of 592 Black or African American adults living in Milwaukee was added to diversify the MIDUS II sample. The MIDUS II Biomarker Project added biological assessments to a subsample of MIDUS participants. Participants were eligible to be part of this subsample if they completed a mail-in questionnaire or telephone interview, lived in the continental United States, and were willing to complete in-person physical assessments (Ryff et al., 2018a). Biomarker collection, which occurred at three general clinical research centers across the United States, included the collection of multiple specimens and comprehensive assessments by trained clinicians and research staff. Participants also completed a self-administered questionnaire and self-reported data regarding sleep (Ryff et al., 2018a). All participants provided written informed consent.

Measures

Childhood trauma

Emotional and physical abuse and neglect and sexual abuse that occurred before 18 years of age were assessed using the Childhood Trauma Questionnaire (CTQ; Bernstein & Fink, 1998), which has been extensively studied and has demonstrated good test–retest reliability (i.e., .85–.88; (Bernstein et al., 1994; Bernstein & Fink, 1998; Paivio & Cramer, 2004). The 25-item CTQ includes five items to assess each type of childhood trauma, with responses scored on a scale of 1 (*never true*) to 5 (*very often true*) and a total possible score of 5–25. Positive items are reverse-coded. Responses to items for each form of childhood trauma were summed, with higher scores indicating more severe exposure to childhood trauma. To assess cumulative childhood trauma, we recoded individual continuous scores for each form of childhood trauma into four categories (i.e., none = 0, low = 1, moderate = 2, severe = 3; (Bernstein & Fink, 1998). Categorical variables for all five forms of childhood trauma were summed to create a cumulative childhood trauma score that ranged from 0, indicating no abuse, to 15, indicating severe emotional and physical abuse and neglect and sexual abuse. In the present sample, Cronbach's alpha was .93.

Demographic characteristics

Demographic characteristics including age (continuous), race/ethnicity, sex, educational attainment, employment, marital status, household income, and current health care insurance coverage were assessed. Among women, menopause status was determined based on responses to the following questions: "Have you had a menstrual period in the last year?" and "Do you know if your menstrual period stopped due to menopause?" Women who reported not having had a menstrual period in the past year or that their menstrual periods had stopped due to menopause were classified as postmenopausal.

TABLE 1 Definition of life's simple 7 criteria

Cardiovascular health metrics	Poor (Score = 0)	Intermediate (Score = 1)	Ideal (Score = 2)
Tobacco use	Current tobacco use	Former smoker (quit less than 12 months ago)	Never smoked or quit smoking more than 12 months ago
Physical activity	No physical activity per week	1–149 min of moderate activity, 1–74 min of vigorous activity, or 1–149 min of combined moderate and vigorous activity	≥ 150 min of moderate activity, ≥ 75 min of vigorous activity, or ≥ 150 min of combined moderate and vigorous activity
Healthy diet score[a]	0–1 ideal components	2 ideal components	3–4 ideal components
Body mass index	≥ 30.00 kg/m^2	25.00–29.99 kg/m^2	< 25.00 kg/m^2
Total cholesterol	≥ 240 mg/dL	200–239 mg/dL or treated to goal	< 200 mg/dL
Blood pressure	Systolic blood pressure ≥ 140 or diastolic blood pressure ≥ 90 mmHg	Systolic blood pressure 120–139, diastolic blood pressure 80–89 mmHg, or treated to goal	Systolic blood pressure < 120 or diastolic blood pressure < 80 mmHg
Fasting plasma glucose	≥ 126 mg/dL	100-125 mg/dL or treated to goal	< 100 mg/dL

Note: Adapted from Lloyd-Jones et al. (2010).

[a]Healthy diet score included intake of fruits and vegetables, fish, fiber-rich whole grains, and sugar-sweetened beverages.

Mediators

Depressive symptoms

Depressive symptoms were measured using the Center for Epidemiological Studies Depression Inventory (CES-D; Radloff, 1977), a 20-item measure of the frequency of past-week depressive symptoms. Item responses on the CES-D are scored using a 4-point Likert scale ranging from 0 (*rarely or none of the time*) to 3 (*most or all of the time*). Responses were summed, with a total possible score of 0–60. Positive items were reverse-coded such that higher scores indicated a higher frequency of depressive symptoms. In the present study, Cronbach's alpha was .89.

Sleep quality

Past-month subjective sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI; (Buysse et al., 1989). The PSQI is used to assess seven components of sleep quality, each of which is scored on a scale of 0–3. Scores were summed to calculate a global PSQI score (range: 0–21), with higher scores indicating poorer sleep quality. In the present study, Cronbach's alpha was .70.

Cardiovascular health

CVH was measured using the LS7 metric, which includes seven components (Lloyd-Jones et al., 2010). Data on tobacco use, physical activity, and diet were obtained from self-administered questionnaires. The LS7 healthy diet score is calculated based on self-reported intake of five dietary components, which include fruits and vegetables, fish, fiber-rich whole grains, sugar-sweetened beverages, and sodium intake (Lloyd-Jones et al., 2010). Because MIDUS does not include information on sodium intake, the healthy diet score was adapted based on previously described methods to include only four dietary components (Boylan & Robert, 2017). For the present study, ideal components of the healthy diet score were determined as follows: (a) fruits and vegetables: at least 5 cups per day, (b) fish: at least 3 servings per week, (c) fiber-rich whole grains: at least 3 servings per day, (d) sugar-sweetened beverages: less than 4 glasses per week. Scores for dietary components were summed to calculate a healthy diet score. Body mass index (BMI), blood pressure, fasting glucose, and total cholesterol were assessed using standardized protocols (Ryff et al., 2018a, 2018b). Participants received a score of 0 (poor), 1 (intermediate), or 2 (ideal) for each metric (Table 1). A total LS7 score, ranging from 0 to 14, was calculated, with higher scores indicating a more favorable CVH.

Data analysis

Analyses were conducted in Stata (Version 16) and *Mplus* (Version 7). A p value less than .05 selected a priori to indicate significance. We first examined sex differences across study variables using t tests and chi-square tests for continuous and categorical variables, respectively, in Stata. The remaining analyses were conducted in *Mplus*. Missing data for LS7 scores and covariates were handled using full information maximum likelihood, which is the default method of handling missing data in *Mplus*. For the main analyses, we used path analyses with linear regression to examine the direct and indirect paths between

childhood trauma and LS7 score, with separate models for each form of childhood trauma and cumulative childhood trauma. Based on previous evidence (Suglia et al., 2018), we hypothesized that (a) increasing severity of each form of childhood trauma would be associated with poorer LS7 scores (i.e., the direct path) and (b) each form of childhood trauma would be associated with higher depressive symptom levels and poorer sleep quality, which would mediate the associations between the severity of childhood trauma and LS7 score (i.e., indirect paths). Given that depressive symptom and sleep quality scores were moderately correlated, $r = .49$, $p < .001$, all models accounted for the correlation between these variables.

We first fit models with the direct paths from each form of childhood trauma to LS7 score. The indirect paths were constrained to equal 0 (i.e., constrained model). Next, we allowed the indirect paths to be freely estimated (i.e., unconstrained model). We compared the fit between models using change in chi-square values and the Bayesian information criterion, with lower values indicating a better model fit. We also used the R^2 estimate for LS7 score to compare models, with a higher R^2 value indicating a better fit. The model that best fit the data was retained.

We used bias-corrected bootstrapping with 1,000 bootstraps to calculate confidence intervals for the indirect paths between different forms of childhood trauma and LS7 score. Bootstrapping allowed significance testing of the indirect paths (Kline, 2015). Models were adjusted for demographic characteristics. For each model, we calculated the percentage of the total effect that was mediated by the indirect paths as follows: (total indirect path/total effect) x 100, expressed as a percentage. Model fit was assessed using the chi-square statistic, comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). A nonsignificant result for the chi-square statistic indicated that the model fit was adequate. However, with larger sample sizes, other measures of fit are recommended (Kenny, 2020). The CFI and TLI are widely used to assess model fit, with values greater than .95 indicating a good fit (Bentler, 1990); models with an RMSEA value less than .05 or an SRMR value less than .08 are preferred (Kline, 2015).

For the exploratory analyses, we used multiple-group analysis to examine whether sex moderated the observed associations between childhood trauma and CVH. We allowed the direct and indirect paths from childhood trauma to LS7 score to vary by sex (i.e., unconstrained model). We also ran constrained models that set the direct and indirect paths from each form of childhood trauma to LS7 score to 0 for men and women (i.e., constrained model). Chi-square tests were conducted to compare the fit of these models (Byrne et al., 1989; Raykov & Marcoulides, 2006). The following equation was used to test the difference in chi-square values between the constrained and unconstrained models. A p value for the chi-square difference statistics between models less than .05 was used to indicate that the constrained model had a significantly poorer fit and was considered to be evidence of moderation by sex (Preacher et al., 2007).

$$\chi^2_{\text{diff}} = \chi^2_{\text{constrained}} - \chi^2_{\text{unconstrained}};\ df_{\text{diff}} = df_{\text{constrained}} - df_{\text{unconstrained}}$$

RESULTS

Descriptive analyses

Women were less likely than men to identify as White; women also reported lower levels of educational attainment and annual household income (Supplementary Table S11). Additionally, women reported poorer sleep quality than men ($M = 6.6$ vs. $M = 5.7$), $p < .001$. Table 2 presents sex differences in the prevalence of childhood trauma and CVH metrics. Women were more likely than men to report more severe childhood emotional (10.4% vs. 3.8%), $p < .001$ and sexual abuse (13.0% vs. 3.2%), $p < .001$ and emotional neglect (8.3% vs. 5.9%), $p = .018$. Women also had higher levels of cumulative childhood trauma compared with men ($M = 3.0$ vs. $M = 2.1$), $p < .001$. Fewer than half of the participants met the ideal criteria for physical activity (48.8%), diet (8.2%), BMI (23.7%), blood pressure (18.5%), and total cholesterol (42.5%). The mean LS7 score was 7.5 ($SD = 2.35$, range: 0–14). Women were more likely than men to meet the ideal criteria for tobacco use (56.6% vs. 47.3%), $p < .001$; diet (9.6% vs. 6.5%), $p = .018$; BMI (28.9% vs. 17.0%), $p < .001$; blood pressure (23.0% vs. 12.6%), $p < .001$; fasting glucose (64.1% vs. 50.7%), $p < .001$; and total cholesterol (44.1% vs. 40.5%), $p = .033$. Men were more likely to meet the ideal criteria for physical activity (55.6% vs. 43.7%), $p < .001$. On average, women had higher LS7 scores than men ($M = 7.6$ vs. $M = 7.3$), $p = .027$.

Main analyses

The model fit statistics indicated that the unconstrained models, with freely estimated indirect paths, fit the data better than models that constrained indirect paths for all forms of childhood trauma (Supplementary Table 2); thus, the unconstrained model was used for all analyses. Table 3 presents the direct and indirect paths between increasing childhood trauma severity and LS7 scores. The estimates presented in Table 3 are unstandardized. All models

TABLE 2 Sex differences in the prevalence of childhood trauma and cardiovascular health metrics

Variable	Total sample ($N = 1,251$)		Men ($n = 541$)		Women ($n = 710$)		Statistical test[b]
	n	%	*n*	%	*n*	%	
Childhood trauma type[a]							
Emotional abuse							$\chi^2(3, N = 1,250) = 29.36^{***}$
None	860	68.8	403	74.5	457	64.4	
Low	222	17.7	97	18.0	125	17.6	
Moderate	73	5.8	20	3.7	53	7.5	
Severe	95	7.6	21	3.8	74	10.4	
Physical abuse							$\chi^2(3, N = 1,251) = 6.37$
None	959	76.7	418	77.3	541	76.2	
Low	130	10.4	65	12.0	65	9.2	
Moderate	85	6.7	32	5.9	53	7.4	
Severe	77	6.2	26	4.8	51	7.2	
Sexual abuse							$\chi^2(3, N = 1,246) = 62.91^{***}$
None	951	76.0	469	86.7	482	67.8	
Low	86	6.9	28	5.1	58	8.2	
Moderate	100	8.0	27	5.0	73	10.3	
Severe	109	8.7	17	3.2	92	13.0	
Emotional neglect							$\chi^2(3, N = 1,250) = 10.01^{*}$
None	698	55.8	303	56.1	395	55.6	
Low	334	26.7	162	29.9	172	24.3	
Moderate	127	10.2	44	8.1	83	11.7	
Severe	91	7.2	32	5.9	59	8.3	
Physical neglect							$\chi^2(3, N = 1,251) = 5.14$
None	902	72.1	398	73.6	504	71.0	
Low	160	12.8	68	12.6	92	13.0	
Moderate	112	9.0	51	9.4	61	8.5	
Severe	77	6.1	24	4.4	53	7.5	
Cardiovascular health metrics							
Tobacco use							$\chi^2(2, N = 1,249) = 18.7^{***}$
Poor	302	24.1	128	23.7	174	24.6	
Intermediate	289	23.1	156	28.8	133	18.7	
Ideal	658	52.6	256	47.3	402	56.6	
Physical activity							$\chi^2(2, N = 1,246) = 17.73^{***}$
Poor	459	36.7	174	32.2	285	40.1	
Intermediate	176	14.1	64	11.8	112	15.8	
Ideal	611	48.8	301	55.6	310	43.7	
Diet							$\chi^2(2, N = 1,249) = 8.50^{*}$
Poor	862	68.9	396	73.2	466	65.6	
Intermediate	284	22.7	110	20.3	174	24.5	
Ideal	103	8.2	35	6.5	68	9.6	
Body mass index							$\chi^2(2, N = 1,250) = 34.51^{***}$
Poor	513	41.0	217	40.1	296	41.7	
Intermediate	440	35.2	232	42.9	208	29.3	
Ideal	297	23.7	92	17.0	205	28.9	

(Continues)

TABLE 2 (Continued)

Variable	Total sample ($N = 1,251$)		Men ($n = 541$)		Women ($n = 710$)		Statistical test[b]
	n	%	*n*	%	*n*	%	
Blood pressure							$\chi^2(2, N = 1,251) = 33.39^{***}$
Poor	257	20.5	96	17.7	161	22.7	
Intermediate	763	61.0	377	69.7	386	54.3	
Ideal	231	18.5	68	12.6	163	23.0	
Fasting glucose							$\chi^2(2, N = 1,227) = 24.39^{***}$
Poor	94	7.5	48	8.8	46	6.5	
Intermediate	404	32.3	210	38.8	194	27.3	
Ideal	729	58.3	274	50.7	455	64.1	
Total cholesterol							$\chi^2(2, N = 1,240) = 7.55^{*}$
Poor	112	9.0	39	7.2	73	10.3	
Intermediate	596	47.6	280	51.8	316	44.5	
Ideal	532	42.5	219	40.5	313	44.1	

Note: $N = 1,251$.

[a]Cumulative childhood trauma ($n = 1,246$): $M = 2.6$, $SD = 3.47$ for the total sample; $M = 2.1$, $SD = 2.89$ for men; $M = 3.0$, $SD = 3.81$ for women; total range: 1–15.

[b]Students' *t* tests and chi-square tests were used to examine sex differences in cardiovascular health metrics.

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$.

demonstrated adequate fit (see Table 4). The direct paths of increasing severity of childhood physical abuse, $B = -0.224$ $SE = 0.08$, $p = .007$; childhood sexual abuse, $B = -0.139$, $SE = 0.07$, $p = .045$; and cumulative childhood trauma, $B = -0.044$, $SE = 0.02$, $p = .011$, were negatively associated with LS7 scores. Depressive symptoms and sleep quality partially mediated the associations between all forms of childhood trauma and LS7 scores. The total effects of all forms of childhood trauma with LS7 scores were significant. The percentage of the total effect mediated by depressive symptoms and sleep quality ranged from 26.8% for physical abuse to 57.5% for physical neglect.

Exploratory analyses

Tables 5–8 present results and fit indices for multiple group analyses. Except for childhood sexual abuse, the total effects of all other forms of childhood trauma and cumulative childhood trauma were negatively associated with LS7 scores for men (Tables 5 and 7). Among women, only the total effects of physical abuse, sexual abuse, and cumulative childhood trauma were negatively associated with LS7 scores. Depressive symptoms partially mediated the associations between all forms of childhood trauma and LS7 scores in women. Chi-square test results indicated that the constrained model had a significantly poorer fit than the unconstrained model for all forms of childhood trauma and cumulative childhood trauma (Tables 6 and 8), indicating that sex moderated the associations between all forms of childhood trauma, as well as cumulative childhood trauma, and LS7 scores.

DISCUSSION

To our knowledge, this was the first study to simultaneously examine (a) the associations between the severity of childhood trauma and the American Heart Association's LS7 measure of CVH, (b) whether depressive symptoms and sleep quality potentially explain these associations, and (c) the moderating role of sex on these associations. Using nationally representative data from the United States, we found that increasing severity of all forms of childhood trauma was related to a less favorable CVH profile in middle-aged adults. These associations were partially explained by depressive symptoms and subjective sleep quality. We also found that sex moderated the associations between all forms of childhood trauma and CVH.

The results of our main analyses are consistent with previous studies that have demonstrated a link between childhood trauma and elevated CVD risk in adults (Davis et al., 2014; Friedman et al., 2015; Lee et al., 2014; Su et al., 2015; Thurston et al., 2018). In a systematic review of 43 studies that examined the associations between childhood adversities and CVD risk, findings from 36% of the included studies showed a significant association between the number of reported childhood adversities and CVD risk (Appleton et al., 2017). A review conducted by Basu and colleagues (2017) found a similar dose–response association between

TABLE 3 Direct and indirect paths between childhood trauma severity and cardiovascular health, by trauma type

Childhood trauma type	Total		Direct		Indirect					
					Total indirect		Childhood abuse → Depressive symptoms → LS7		Childhood abuse → Sleep quality → LS7	
	B	*SE*	*B*	*SE*	*B*	95% CI	*B*	95% CI	*B*	95% CI
Emotional abuse	−0.225**	0.08	−0.119	0.08	−0.106***	[−0.154, −0.066]	−0.052*	[−0.097, −0.014]	−0.054**	[−0.092, −0.022]
Physical abuse	−0.306***	0.08	−0.224**	0.08	−0.082***	[−0.120, −0.043]	−0.035*	[−0.066, −0.004]	−0.038**	[−0.081, −0.012]
Sexual abuse	−0.208**	0.07	−0.139*	0.07	−0.069***	[−0.103, −0.035]	−0.032*	[−0.060, −0.004]	−0.037**	[−0.065, −0.006]
Emotional neglect	−0.170*	0.07	−0.077	0.07	−0.093***	[−0.140, −0.046]	−0.054*	[−0.100, −0.008]	−0.038**	[−0.067, −0.010]
Physical neglect	−0.160*	0.08	−0.069	0.08	−0.092***	[−0.135, −0.048]	−0.048*	[−0.087, −0.008]	−0.044**	[−0.075, −0.013]
Cumulative trauma[a]	−0.076***	0.02	−0.044*	0.02	−0.028***	[−0.041, −0.015]	−0.015*	[−0.027, −0.002]	−0.013*	[−0.023, −0.003]

Note: $N = 1{,}251$. All models were adjusted for age, race/ethnicity, sex, educational attainment, employment status, marital status, household income, menopausal status, and healthcare insurance coverage. Total effects mediated by the indirect paths: 47.1% for childhood emotional abuse, 26.8% for childhood physical abuse, 33.2% for childhood sexual abuse, 54.7% for childhood emotional neglect, 57.5% for childhood physical neglect, and 39.4% for cumulative trauma. LS7 = Life's Simple 7 score.

[a]Score determined by the sum of emotional and physical abuse and neglect and sexual abuse scores (range: 0–15).

*$p < .05$, **$p < .01$, ***$p < .001$.

TABLE 4 Fit indices for the direct and indirect paths between childhood trauma severity and cardiovascular health, by trauma type[a]

Childhood trauma type	$\chi^2(2, N = 1{,}251)$	*p*	CFI	TLI	RMSEA	95% CI	SRMR
Emotional abuse	2.44	.294	1.00	.99	.013	[.000, .059]	.003
Physical abuse	2.54	.279	1.00	.99	.015	[.000, .060]	.004
Sexual abuse	2.61	.269	1.00	.99	.016	[.000, .061]	.004
Emotional neglect	2.69	.261	1.00	.99	.017	[.000, .061]	.003
Physical neglect	2.47	.291	1.00	.99	.014	[.000, .060]	.003
Cumulative trauma	2.44	.295	1.00	.99	.013	[.000, .059]	.003

Note: CFI = comparative factor index; TLI = Tucker–Lewis Index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual.

[a]Cumulative childhood trauma score was determined by the sum of emotional, physical, and sexual abuse scores (range: 0–15). Cardiovascular health was measured using the cumulative Life's Simple 7 score.

an increasing number of reported childhood adversities and a higher risk of CVD in adults. The association between the severity of childhood trauma exposure and CVH indicates that efforts to decrease the prevalence and severity of childhood trauma exposure could reduce the influence of childhood trauma on CVH in midlife.

The present study provides a better understanding of modifiable factors that potentially explain the associations between childhood trauma and CVH in midlife. There is growing evidence that psychosocial stressors, such as depressive symptoms, contribute to poor CVH in adults (Bomhof-Roordink et al., 2015; Garcia et al., 2016; Mehta

TABLE 5 Results of multiple group analyses of direct and indirect paths between childhood emotional, physical, and sexual abuse severity and cardiovascular health, by sex

	Men			Women		
Path	***B***	***SE***	**95% CI**	***B***	***SE***	**95% CI**
Childhood emotional abuse						
Total	−0.430**	0.130		−0.135	0.094	
Direct	−0.340*	0.134		−0.020	0.096	
Indirect						
Total	−0.090*		[−0.174, −0.006]	−0.116***		[−0.178, −0.054]
Childhood abuse → Depressive symptoms → LS7	−0.017		[−0.096, 0.062]	−0.067*		[−0.126, −0.009]
Childhood abuse → Sleep quality → LS7	−0.072*		[−0.144, −0.001]	−0.048*		[−0.094, −0.002]
Childhood physical abuse						
Total	−0.378**	0.113		−0.256*	0.101	
Direct	−0.315**	0.112		−0.160	0.101	
Indirect						
Total	−0.062*		[−0.116, −0.009]	−0.096**		[−0.152, −0.040]
Childhood abuse → Depressive symptoms → LS7	−0.014		[−0.055, 0.026]	−0.048*		[−0.096, −0.001]
Childhood abuse → Sleep quality → LS7	−0.048		[−0.099, 0.003]	−0.048		[−0.096, 0.000]
Childhood sexual abuse						
Total	−0.098	0.135		−0.238**	0.078	
Direct	−0.061	0.136		−0.154*	0.078	
Indirect						
Total	−0.037		[−0.089, 0.015]	−0.084***		[−0.131, −0.037]
Childhood abuse → Depressive symptoms → LS7	−0.010		[−0.039, 0.019]	−0.045*		[−0.085, −0.004]
Childhood abuse → Sleep quality → LS7	−0.027		[−0.071, 0.018]	−0.039		[−0.081, 0.002]

Note: $N = 1{,}251$, $n = 541$ men, $n = 710$ women. All models were adjusted for age, race/ethnicity, sex, educational attainment, employment status, marital status, household income, menopausal status, and healthcare insurance coverage. The total effects mediated by the indirect paths for emotional abuse were 20.9% for men and 85.9% for women. The total effects mediated by the indirect paths for physical abuse were 16.4% for men and 37.5% for women. The total effects mediated by the indirect paths for sexual abuse were 37.8% for men and 35.3% for women. LS7 = Life's Simple 7 score.

*$p < .05$, **$p < .01$, ***$p < .001$.

TABLE 6 Fit indices for multiple group analyses of direct and indirect paths between childhood emotional, physical, and sexual abuse severity and cardiovascular health, by sex[a]

Childhood trauma type	$\chi^2(4, N = 1{,}251)$	*p*	CFI	TLI	RMSEA	95% CI	SRMR	$\Delta\chi^2(10)$[b]	*p*
Emotional abuse	2.69	.608	1.00	1.00	.000	[.000, .050]	0.004	146.93	< .001
Physical abuse	2.67	.612	1.00	1.00	.000	[.000, .050]	0.004	97.74	< .001
Sexual abuse	2.91	.574	1.00	1.00	.000	[.000, .052]	0.004	84.12	< .001

Note: $N = 1{,}251$, $n = 541$ men, $n = 710$ women. Men: $n = 541$; Women: $n = 710$. LS7 = Life's Simple 7; CFI = comparative factor index; TLI = Tucker–Lewis Index; RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual. All models adjusted for age, race/ethnicity, education, marital status, household income, postmenopausal status, and healthcare insurance coverage.

[a]Cardiovascular health was measured using the cumulative LS7 score. [b]Used to compare the unconstrained (i.e., freely estimated) and constrained (i.e., direct and indirect paths constrained to equal 0). A chi-square *p* value < .05 indicates evidence of moderation by sex.

TABLE 7 Results of multiple group analyses of direct and indirect paths of childhood neglect and cumulative childhood trauma severity and cardiovascular health, by sex

	Men			Women		
Path	***B***	***SE***	**95% CI**	***B***	***SE***	**95% CI**
Childhood emotional neglect						
Total	−0.373**	0.109		−0.040	0.102	
Direct	−0.297*	0.117		0.056	0.100	
Indirect						
Total	−0.076		[−0.157, 0.008]	−0.096**		[−0.157, −0.034]
Childhood abuse → Depressive symptoms → LS7	−0.010		[−0.091, 0.057)	−0.073*		[−0.133, −0.012]
Childhood abuse → Sleep quality → LS7	−0.066*		[−0.128, −0.005]	−0.023		[−0.052, 0.007]
Childhood physical neglect						
Total	−0.251*	0.111		−0.112	0.099	
Direct	−0.162	0.117		−0.022	0.099	
Indirect						
Total	−0.089*		[−0.164, −0.014]	−0.089***		[−0.142, −0.037]
Childhood abuse → Depressive symptoms → LS7	−0.022		[−0.090, 0.046]	−0.057*		[−0.105, −0.008]
Childhood abuse → Sleep quality → LS7	−0.067*		[−0.130, −0.004]	−0.033		[−0.068, 0.003]
Cumulative childhood trauma						
Total	−0.118***	0.032		−0.055*	0.024	
Direct	−0.094**	0.033		−0.024	0.078	
Indirect						
Total	−0.024*		[−0.047, −0.001]	−0.032***		[−0.048, −0.015]
Childhood abuse → Depressive symptoms → LS7	−0.004		[−0.026, 0.019]	−0.018*		[−0.035, −0.002]
Childhood abuse → Sleep quality → LS7	−0.020*		[−0.040, −0.001]	−0.013*		[−0.026, −0.001]

Note: $N = 1{,}251$, $n = 541$ men, $n = 710$ women. All models were adjusted for age, race/ethnicity, sex, educational attainment, employment status, marital status, household income, menopausal status, and healthcare insurance coverage. The total effects mediated by the indirect paths for emotional neglect were 20.3% for men. We were unable to determine the percent of the total effect of emotional neglect on LS7 that was mediated by the indirect paths for women because the indirect effect was greater than the total effect. The total effects mediated by the indirect paths for physical neglect were 35.5% for men and 79.5% for women. The total effects mediated by the indirect paths for cumulative childhood trauma were 20.3% for men and 58.2% for women. LS7 = Life's Simple 7 score.

*$p < .05$, **$p < .01$, ***$p < .001$.

TABLE 8 Fit indices for multiple group analyses of direct and indirect paths between childhood neglect and cumulative childhood trauma and cardiovascular health, by sex

Childhood trauma type	$\chi^2(4, N = 1{,}251)$	*p*	CFI	TLI	RMSEA	95% CI	SRMR	$\Delta\chi^2(10)$[a]	*p*
Emotional neglect	2.58	0.633	1.00	1.00	0.000	[0.000, 0.049]	0.004	159.69	< .001
Physical neglect	2.52	0.642	1.00	1.00	0.000	[0.000, 0.049]	0.004	116.41	< .001
Cumulative trauma	2.43	0.658	1.00	1.00	0.000	[0.000, 0.048]	0.004	175.64	< .001

Note: $N = 1{,}251$, $n = 541$ men, $n = 710$ women. All models adjusted for age, race/ethnicity, educational attainment, marital status, household income, post-menopausal status, and healthcare insurance coverage.

[a]Used to compare the unconstrained (i.e., freely estimated) and constrained (i.e., direct and indirect paths constrained to equal 0). A chi-square *p* value < .05 indicates evidence of moderation by sex.

et al., 2015). Bomhof-Roordink and colleagues (2015) found that depressive symptoms partially mediated the association between life stressors, such as childhood trauma exposure and daily hassles, and subclinical CVD (e.g., carotid atherosclerosis). With regard to sleep, Petrov et al. (2016) found that sleep quality significantly mediated the association between childhood trauma and hypertension in a community sample of 589 middle-aged adults. Similarly, in a recent study of 115 women aged 18–39 years, investigators identified sleep quality as a potential mediator in the association between childhood adversity and CVD risk (Van Dammen et al., 2019). The present findings suggest that further research is needed to determine whether reducing depressive symptoms and improving sleep quality can improve CVH in survivors of childhood trauma. These findings can inform tailored CVD prevention efforts and the development of targeted CVD prevention in individuals who have experienced childhood trauma. For instance, the present findings support the need for future psychosocial and behavioral interventions that assess depressive symptoms and sleep quality as treatment targets to reduce CVD risk in adults who have experienced childhood trauma.

A strength of the present study was the examination of sex differences in the associations between childhood trauma and CVH. Despite a growing number of studies that have investigated whether sex influences the link between childhood trauma and cardiovascular health, significant knowledge gaps remain. Few investigators have assessed sex differences in LS7 scores. Our bivariate analyses revealed that women had more favorable CVH profiles than men. Consistent with our findings, analyses of data from the Hispanic Community Health Study/Study of Latinos found that women had higher LS7 scores but were less likely to meet the ideal criteria for physical activity than men (González et al., 2016).

Overall, increasing severity of all forms of childhood trauma, except childhood sexual abuse, and more severe cumulative childhood trauma were more negatively associated with LS7 among men relative to women. This is consistent with prior analyses of MIDUS II Biomarker Project data that examined sex differences in the associations between childhood abuse and metabolic syndrome (Lee et al., 2014). Although Lee et al. (2014) found no evidence of moderation by sex, they observed that the effects of childhood emotional, physical, and cumulative abuse on metabolic syndrome, which includes two of the CVH metrics examined in the present study, were stronger for men than women. Lee and colleagues' outcome, metabolic syndrome, was dichotomous; therefore, the authors may have lacked statistical power to detect moderation by sex. Given the contradictory findings on sex differences in previous work (Friedman et al., 2015; Suglia et al., 2014; Sweeney et al., 2015), further research is needed to examine the reasons for these inconsistent findings. This future work could inform sex-specific approaches for CVD risk reduction in individuals who have experienced childhood trauma.

The global burden of childhood trauma and CVD warrants further attention to childhood trauma as a risk factor for poor CVH in adulthood. The present study supports the need for trauma-informed care that recognizes the impact of trauma exposure on CVH among individuals with childhood trauma histories. Trauma-informed care is a strengths-based approach that emphasizes the holistic care of trauma-exposed individuals and avoids retraumatizing or blaming trauma survivors as they manage their reactions to traumatic experiences (Hopper et al., 2010). Researchers should develop and test models of trauma-informed care to reduce CVD risk in adults who have been exposed to childhood trauma (Suglia et al., 2018). These approaches to trauma-informed care should include the assessment of other social and structural determinants of health, such as intimate partner violence and structural racism, among individuals who have experienced childhood trauma (Lewis-O'Connor et al., 2019). Further, clinicians should assess depressive symptoms and sleep quality as potential risk factors for poor CVH in middle-aged and older adults who report a history of childhood trauma. Targeting depressive symptoms and poor sleep quality among individuals with trauma histories may mitigate their detrimental impact on CVH later in life.

The present study had several methodological limitations. We used cross-sectional data, and, therefore, we cannot infer causality from these findings, particularly for the associations between the proposed mediators and CVH. It is possible that CVH acts as a mediator in the associations between childhood trauma and both depressive symptoms and sleep quality. Reports of childhood trauma should be interpreted with caution, as the use of cross-sectional data for mediation analyses can lead to recall bias, which can result in an overestimation of the associations between childhood trauma and adult health (Sheikh et al., 2016). However, the findings from a recent study demonstrated that retrospective report of childhood trauma was strongly associated with objective measures (i.e., court-documented evidence of childhood maltreatment; (Danese & Widom, 2020). In addition, subjective report of childhood trauma was strongly correlated with psychopathology, such as posttraumatic stress disorder (PTSD), regardless of the strength of the association between subjective and objective measures of childhood trauma. Longitudinal studies that investigate how subjective and objective measures of childhood trauma influence CVH across adulthood can help inform the development of targeted interventions to reduce

CVD risk in individuals who have experienced childhood trauma.

Measurement limitations were also identified. Individuals who experience childhood trauma have been shown to have higher rates of PTSD, a condition that is associated with increased CVD risk (Burg & Soufer, 2016; Edmondson et al., 2018) but was not assessed in MIDUS II. The present paper focused on childhood trauma; however, other psychosocial factors may also impact CVH in midlife, and we did not include potential confounders, such as childhood poverty, adult victimization, revictimization, or discrimination, that may be correlated with CVH (Evans & Fuller-Rowell, 2013; Mason et al., 2012; Stene et al., 2013; Widom et al., 2008). Future studies should include these potential confounders to examine if they attenuate the observed associations between childhood trauma exposure and CVH. Aside from subjective sleep quality, we did not assess additional dimensions of sleep health that may contribute to poor sleep quality, such as sleep apnea. Finally, we were unable to assess whether the time of onset or length of exposure to childhood trauma impacted CVH.

The present study provides a better understanding of the associations between childhood trauma and CVH in midlife. All forms of childhood trauma were associated with poorer CVH. Depressive symptoms and sleep quality partially explained these associations, which were moderated by sex. Our findings can inform interventions and sex-specific approaches to screening for and addressing childhood trauma. Longitudinal studies in multiethnic samples of adults are needed to extend the present findings and decipher these relations across adulthood. Future studies should also simultaneously examine the influence of childhood trauma and other psychosocial factors that contribute to poor CVH in midlife.

OPEN PRACTICES STATEMENT

The present analysis was not preregistered. We analyzed archival data that are not under our direct control; requests to access the data should be directed to the relevant archive. Our complete analysis scripts and codebook have been posted at the Open Science Framework under the title of this manuscript.

ORCID

Billy A. Caceres https://orcid.org/0000-0001-6865-5546

REFERENCES

Abajobir, A. A., Kisely, S., Williams, G., Strathearn, L., & Najman, J. M. (2017). Childhood maltreatment and high dietary fat intake behaviors in adulthood: A birth cohort study. *Child Abuse and Neglect*, *72*(June), 147–153. https://doi.org/10.1016/j.chiabu.2017.08.002

Appleton, A. A., Holdsworth, E., Ryan, M., & Tracy, M. (2017). Measuring childhood adversity in life course cardiovascular research: A systematic review. *Psychosomatic Medicine*, *79*(4), 434–440. https://doi.org/10.1097/PSY.0000000000000430

Basu, A., McLaughlin, K. A., Misra, S., & Koenen, K. C. (2017). Childhood maltreatment and health impact: The examples of cardiovascular disease and type 2 diabetes mellitus in adults. *Clinical Psychology*, *24*(2), 125–139. https://doi.org/10.1111/cpsp.12191

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin*, *107*(2), 238–246.

Bernstein, D. P., & Fink, L. (1998). *Childhood Trauma Questionnaire: A retrospective self-report manual*. The Psychological Corporation.

Bernstein, D. P., Fink, L., Handelsman, L., Foote, J., Lovejoy, M., Wenzel, K., Sapareto, E., & Ruggiero, J. (1994). Initial reliability and validity of a new retrospective measure of child abuse and neglect. *The American Journal of Psychiatry*, *151*(8), 1132–1136. https://doi.org/10.1176/ajp.151.8.1132

Bomhof-Roordink, H., Seldenrijk, A., van Hout, H. P. J., van Marwijk, H. W. J., Diamant, M., & Penninx, B. W. J. H. (2015). Associations between life stress and subclinical cardiovascular disease are partly mediated by depressive and anxiety symptoms. *Journal of Psychosomatic Research*, *78*(4), 332–339. https://doi.org/10.1016/j.jpsychores.2015.02.009

Boylan, J. M., & Robert, S. A. (2017). Neighborhood SES is particularly important to the cardiovascular health of low SES individuals. *Social Science and Medicine*, *188*, 60–68. https://doi.org/10.1016/j.socscimed.2017.07.005

Burg, M. M., & Soufer, R. (2016). Post-traumatic stress disorder and cardiovascular disease. *Current Cardiology Reports*, *18*(10), 1–7. https://doi.org/10.1007/s11886-016-0770-5

Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., Kupfer, D. J., III, C. F. R., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research*, *28*(2), 193–213. https://doi.org/10.1016/0165-1781(89)90047-4

Byrne, B. M., Shavelson, R. J., & Muthén, B. (1989). Testing for the equivalence of factor covariance and mean structures: The issue of partial measurement invariance. *Psychological Bulletin*, *105*(3), 456–466. https://doi.org/10.1037/0033-2909.105.3.456

Centers for Disease Control and Prevention. (2021). *Preventing child abuse & neglect*. https://www.cdc.gov/violenceprevention/childabuseandneglect/fastfact.html

Colafella, K. M. M., & Denton, K. M. (2018). Sex-specific differences in hypertension and associated cardiovascular disease. *Nature Reviews Nephrology*, *14*(3), 185–201. https://doi.org/10.1038/nrneph.2017.189

Danese, A., & Widom, C. S. (2020). Objective and subjective experiences of child maltreatment and their relationships with psychopathology. *Nature Human Behaviour*, *4*(8), 811–818. https://doi.org/10.1038/s41562-020-0880-3

Dasinger, J. H., & Alexander, B. T. (2016). Gender differences in developmental programming of cardiovascular diseases. *Clinical Science*, *130*(5), 337–348. https://doi.org/10.1042/CS20150611

Davis, C. R., Usher, N., Dearing, E., Barkai, A. R., Crowell-Doom, C., Neupert, S. D., Mantzoros, C. S., & Crowell, J. A. (2014). Attachment and the metabolic syndrome in midlife.

Psychosomatic Medicine, *76*(8), 611–621. https://doi.org/10.1097/PSY.0000000000000107

de Waal, M. M., Dekker, J. J. M., Kikkert, M. J., Kleinhesselink, M. D., & Goudriaan, A. E. (2017). Gender differences in characteristics of physical and sexual victimization in patients with dual diagnosis: A cross-sectional study. *Bmc Psychiatry [Electronic Resource]*, *17*(1), 1–9. https://doi.org/10.1186/s12888-017-1413-0

Edmondson, D., Sumner, J. A., Kronish, I. M., Burg, M. M., Oyesiku, L., & Schwartz, J. E. (2018). The association of posttraumatic stress disorder with clinic and ambulatory blood pressure in healthy adults. *Psychosomatic Medicine*, *80*(1), 55–61. https://doi.org/10.1097/PSY.0000000000000523

Evans, G. W., & Fuller-Rowell, T. E. (2013). Childhood poverty, chronic stress, and young adult working memory: The protective role of self-regulatory capacity. *Developmental Science*, *16*(5), 688–696. https://doi.org/10.1111/desc.12082

Fang, N., Jiang, M., & Fan, Y. (2016). Ideal cardiovascular health metrics and risk of cardiovascular disease or mortality: A meta-analysis. *International Journal of Cardiology*, *214*(8), 279–283. https://doi.org/10.1016/j.ijcard.2016.03.210

Finkelhor, D., Turner, H. A., Shattuck, A., & Hamby, S. L. (2013). Violence, crime, and abuse exposure in a national sample of children and youth an update. *JAMA Pediatrics*, *167*(7), 614–621. https://doi.org/10.1001/jamapediatrics.2013.42

Ford, E. S., Greenlund, K. J., & Hong, Y. (2012). Ideal cardiovascular health and mortality from all causes and diseases of the circulatory system among adults in the United States. *Circulation*, *125*(8), 987–995. https://doi.org/10.1161/CIRCULATIONAHA.111.049122

Friedman, E. M., Montez, J. K., Sheehan, C. M., Guenewald, T. L., & Seeman, T. E. (2015). Childhood adversities and adult cardiometabolic health: Does the quantity, timing, and type of adversity matter? *Journal of Aging and Health*, *27*(8), 1311–1338. https://doi.org/10.1177/0898264315580122

Fuller-Thomson, E., Brennenstuhl, S., & Frank, J. (2010). The association between childhood physical abuse and heart disease in adulthood: Findings from a representative community sample. *Child Abuse and Neglect*, *34*(9), 689–698. https://doi.org/10.1016/j.chiabu.2010.02.005

Garcia, M., Mulvagh, S. L., Merz, C. N. B., Buring, J. E., & Manson, J. A. E. (2016). Cardiovascular disease in women: Clinical perspectives. *Circulation Research*, *118*(8), 1273–1293. https://doi.org/10.1161/CIRCRESAHA.116.307547

Gaye, B., Tafflet, M., Arveiler, D., Montaye, M., Wagner, A., Ruidavets, J., Kee, F., Evans, A., Amouyel, P., Ferrieres, J., & Empana, J. (2017). Ideal cardiovascular health and incident cardiovascular disease: Heterogeneity across event subtypes and mediating effect of blood biomarkers: The PRIME Study. *Journal of the American Heart Association*, *6*(10), e006389. https://doi.org/10.1161/JAHA.117.006389

González, H. M., Tarraf, W., Rodríguez, C. J., Gallo, L. C., Sacco, R. L., Talavera, G. A., Heiss, G., Kizer, J. R., Hernandez, R., Davis, S., Schneiderman, N., Daviglus, M. L., & Kaplan, R. C. (2016). Cardiovascular health among diverse Hispanics/Latinos: Hispanic Community Health Study/Study of Latinos (HCHS/SOL) results. *American Heart Journal*, *176*(1), 134–144. https://doi.org/10.1016/j.ahj.2016.02.008

Hoag, J. R., Wu, H., & Grady, J. J. (2015). Impact of childhood abuse on adult sleep quality among low-income women after Hurricane Ike. *Sleep Health*, *1*(4), 293–299. https://doi.org/10.1016/j.sleh.2015.09.001

Hopper, E. K., Bassuk, E. L., & Olivet, J. (2010). Shelter from the storm: Trauma-informed care in homelessness services settings. *The Open Health Services and Policy Journal*, *3*(2), 80–100. https://doi.org/10.2174/1874924001003020080

Infurna, M. R., Reichl, C., Parzer, P., Schimmenti, A., Bifulco, A., & Kaess, M. (2016). Associations between depression and specific childhood experiences of abuse and neglect: A meta-analysis. *Journal of Affective Disorders*, *190*, 47–55. https://doi.org/10.1016/j.jad.2015.09.006

Jobe-Shields, L., Moreland, A. D., Hanson, R. F., Amstadter, A., Saunders, B. E., & Kilpatrick, D. G. (2018). Co-occurrence of witnessed parental violence and child physical abuse from a national sample of adolescents. *Journal of Child and Adolescent Trauma*, *11*(2), 129–139. https://doi.org/10.1007/s40653-015-0057-9

Kahl, K. G., Schweiger, U., Correll, C., Müller, C., Busch, M. L., Bauer, M., & Schwarz, P. (2015). Depression, anxiety disorders, and metabolic syndrome in a population at risk for type 2 diabetes mellitus. *Brain and Behavior*, *5*(3), e00306. https://doi.org/10.1002/brb3.306

Kenny, D. A. (2020). *Measuring model fit*. http://davidakenny.net/cm/fit.htm

Kline, R. B. (2015). *Principles and practice of structural equation modeling*. (4th ed.). Guilford Press.

Kreatsoulas, C., Fleegler, E. W., Kubzansky, L. D., McGorrian, C. M., & Subramanian, S. V. (2019). Young adults and adverse childhood events: A potent measure of cardiovascular risk. *American Journal of Medicine*, *132*(5), 605–613. https://doi.org/10.1016/j.amjmed.2018.12.022

Lee, C., Tsenkova, V., & Carr, D. (2014). Childhood trauma and metabolic syndrome in men and women. *Social Science & Medicine*, *105*(3), 122–130. https://doi.org/10.1016/j.socscimed.2014.01.017

Lewis-O'Connor, A., Warren, A., Lee, J. V., Levy-Carrick, N., Grossman, S., Chadwick, M., Stoklosa, H., & Rittenberg, E. (2019). The state of the science on trauma inquiry. *Women's Health*, *15*, 174550651986123. https://doi.org/10.1177/1745506519861234

Liu, Y., Zhang, N., Bao, G., Huang, Y., Ji, B., Wu, Y., Liu, C., & Li, G. (2019). Predictors of depressive symptoms in college students: A systematic review and meta-analysis of cohort studies. *Journal of Affective Disorders*, *244*, 196–208. https://doi.org/10.1016/j.jad.2018.10.084

Lloyd-Jones, D. M., Hong, Y., Labarthe, D., Mozaffarian, D., Appel, L. J., Van Horn, L., Greenlund, K., Daniels, S., Nichol, G., Tomaselli, G. F., Arnett, D. K., Fonarow, G. C., Ho, P. M., Lauer, M. S., Masoudi, F. A., Robertson, R. M., Roger, V., Schwamm, L. H., Sorlie, P., … American Heart Association Strategic Planning Task Force and Statistics Committee. (2010). Defining and setting national goals for cardiovascular health promotion and disease reduction: The American Heart Association's Strategic Impact Goal through 2020 and beyond. *Circulation*, *121*(4), 586–613. https://doi.org/10.1161/CIRCULATIONAHA.109.192703

Mandelli, L., Petrelli, C., & Serretti, A. (2015). The role of specific early trauma in adult depression: A meta-analysis of published literature. Childhood trauma and adult depression. *European Psychiatry*, *30*(6), 665–680. https://doi.org/10.1016/j.eurpsy.2015.04.007

Mason, S. M., Wright, R. J., Hibert, E. N., Spiegelman, D., Forman, J. P., & Rich-Edwards, J. W. (2012). Intimate partner violence and

incidence of hypertension in women. *Annals of Epidemiology*, *22*(8), 562–567. https://doi.org/10.1016/j.annepidem.2012.05.003

Mehta, P. K., Wei, J., & Wenger, N. K. (2015). Ischemic heart disease in women: A focus on risk factors. *Trends in Cardiovascular Medicine*, *25*(2), 140–151. https://doi.org/10.1016/j.tcm.2014.10.005

Meng, X., & D'Arcy, C. (2016). Gender moderates the relationship between childhood abuse and internalizing and substance use disorders later in life: A cross-sectional analysis. *Bmc Psychiatry [Electronic Resource]*, *16*(1), 1–13. https://doi.org/10.1186/s12888-016-1071-7

O'Donnell, M. J., Denis, X., Liu, L., Zhang, H., Chin, S. L., Rao-Melacini, P., Rangarajan, S., Islam, S., Pais, P., McQueen, M. J., Mondo, C., Damasceno, A., Lopez-Jaramillo, P., Hankey, G. J., Dans, A. L., Yusoff, K., Truelsen, T., Diener, H. C., Sacco, R. L., … Yusuf, S. (2010). Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): A case-control study. *The Lancet*, *376*(9735), 112–123. https://doi.org/10.1016/S0140-6736(10)60834-3

Ommerborn, M. J., Blackshear, C. T., Hickson, D. A., Griswold, M. E., Kwatra, J., Djoussé, L., & Clark, C. R. (2016). Ideal cardiovascular health and incident cardiovascular events: The Jackson Heart Study. *American Journal of Preventive Medicine*, *51*(4), 502–506. https://doi.org/10.1016/j.amepre.2016.07.003

Oyola, M. G., & Handa, R. J. (2017). Hypothalamic–pituitary–adrenal and hypothalamic–pituitary–gonadal axes: Sex differences in regulation of stress responsivity. *Stress (Amsterdam, Netherlands)*, *20*(5), 476–494. https://doi.org/10.1080/10253890.2017.1369523

Paivio, S. C., & Cramer, K. M. (2004). Factor structure and reliability of the Childhood Trauma Questionnaire in a Canadian undergraduate student sample. *Child Abuse & Neglect*, *28*(8), 889–904. https://doi.org/10.1016/j.chiabu.2004.01.011

Pase, M. P., Beiser, A., Enserro, D., Xanthakis, V., Aparicio, H., Satizabal, C. L., Himali, J. J., Kase, C. S., Vasan, R. S., DeCarli, C., & Seshadri, S. (2016). Association of ideal cardiovascular health with vascular brain injury and incident dementia. *Stroke; A Journal of Cerebral Circulation*, *47*(5), 1201–1206. https://doi.org/10.1161/STROKEAHA.115.012608

Petrov, M. E., Davis, M. C., Belyea, M. J., & Zautra, A. J. (2016). Linking childhood abuse and hypertension: Sleep disturbance and inflammation as mediators. *Journal of Behavioral Medicine*, *39*(4), 716–726. https://doi.org/10.1007/s10865-016-9742-x

Preacher, K. J., Rucker, D. D., & Hayes, A. F. (2007). Addressing moderated mediation hypotheses: Theory, methods, and prescriptions. *Multivariate Behavioral Research*, *42*(1), 185–227. https://doi.org/10.1080/00273170701341316

Raykov, T., & Marcoulides, G. A. (2006). *A first course in structural equation modeling* (2nd ed.). Lawrence Erlbaum Associates, Inc.

Ruiz, A. L., & Font, S. A. (2020). Role of childhood maltreatment on weight and weight-related behaviors in adulthood. *Health Psychology*, *39*(11), 986–996. https://doi.org/10.1037/hea0001027

Ryff, C. D., Seeman, T., & Weinstein, M. (2018a). *Midlife in the United States (MIDUS 2): Biomarker Project, 2004–2009: Blood, urine, and saliva data*.

Ryff, C. D., Seeman, T., & Weinstein, M. (2018b). *Midlife in the United States (MIDUS 2): Biomarker Project, 2004–2009: Physical examination data*.

Sheikh, M. A., Abelsen, B., & Olsen, J. A. (2016). Differential recall bias, intermediate confounding, and mediation analysis in life course epidemiology: An analytic framework with empirical example. *Frontiers in Psychology*, *7*(Nov), 1–16. https://doi.org/10.3389/fpsyg.2016.01828

Stene, L. E., Jacobsen, G. W., Dyb, G., Tverdal, A., & Schei, B. (2013). Intimate partner violence and cardiovascular risk in women: A population-based cohort study. *Journal of Women's Health*, *22*(3), 250–258. https://doi.org/10.1089/jwh.2012.3920

Su, S., Wang, X., Pollock, J. S., Treiber, F. A., Xu, X., Snieder, H., McCall, W. V., Stefanek, M., & Harshfield, G. A. (2015). Adverse childhood experiences and blood pressure trajectories from childhood to young adulthood: The Georgia Stress and Heart Study. *Circulation*, *131*(19), 1674–1681. https://doi.org/10.1161/CIRCULATIONAHA.114.013104

Suglia, S. F., Clark, C. J., Boynton-Jarrett, R., Kressin, N. R., & Koenen, K. C. (2014). Child maltreatment and hypertension in young adulthood. *Bmc Public Health [Electronic Resource]*, *14*(1), 1149. https://doi.org/10.1186/1471-2458-14-1149

Suglia, S. F., Koenen, K. C., Boynton-Jarrett, R., Chan, P. S., Clark, C. J., Danese, A., Faith, M. S., Goldstein, B. I., Hayman, L. L., Isasi, C. R., Pratt, C. A., Slopen, N., Sumner, J. A., Turer, A., Turer, C. B., Zachariah, J. P., & American Heart Association Council on Epidemiology and Prevention; Council on Cardiovascular Disease in the Young; Council on Functional Genomics and Translational Biology; Council on Cardiovascular and Stroke Nursing; and Council on Quality of Care and O. (2018). Childhood and adolescent adversity and cardiometabolic outcomes: A Scientific Statement from the American Heart Association. *Circulation*, *137*(5), e15–e28. https://doi.org/10.1161/cir.0000000000000536

Sweeney, S., Air, T., Zannettino, L., & Galletly, C. (2015). Gender differences in the physical and psychological manifestation of childhood trauma and/or adversity in people with psychosis. *Frontiers in Psychology*, *6*(Nov), 1–8. https://doi.org/10.3389/fpsyg.2015.01768

Thompson, M. P., Kingree, J. B., & Desai, S. (2004). Gender differences in long-term health consequences of physical abuse of children: Data from a nationally representative survey. *American Journal of Public Health*, *94*(4), 599–604. https://doi.org/10.2105/AJPH.94.4.599

Thordardottir, E. B., Hansdottir, I., Valdimarsdottir, U. A., Shipherd, J. C., Resnick, H., & Gudmundsdottir, B. (2016). The manifestations of sleep disturbances 16 years post-trauma. *Sleep*, *39*(8), 1551–1554. https://doi.org/10.5665/sleep.6018

Thurston, R. C., Barinas-Mitchell, E., von Känel, R., Chang, Y., Koenen, K. C., & Matthews, K. A. (2018). Trauma exposure and endothelial function among midlife women. *Menopause*, *25*(4), 368–374. https://doi.org/10.1097/GME.0000000000001036

Van Dammen, L., Bush, N. R., De Rooij, S. R., Mol, B. W. J., Groen, H., Hoek, A., & Roseboom, T. J. (2019). Childhood adversity and women's cardiometabolic health in adulthood: Associations with health behaviors, psychological distress, mood symptoms, and personality. *BMC Women's Health*, *19*(1), 9–11. https://doi.org/10.1186/s12905-019-0797-z

Varlamov, O., Bethea, C. L., & Roberts, C. T. (2014). Sex-specific differences in lipid and glucose metabolism. *Frontiers in Endocrinology*, *5*(DEC), 1–7. https://doi.org/10.3389/fendo.2014.00241

Whitworth, S. R., Bruce, D. G., Starkstein, S. E., Davis, W. A., Davis, T. M. E., & Bucks, R. S. (2016). Lifetime depression and anxiety increase prevalent psychological symptoms and worsen glycemic control in type 2 diabetes: The Fremantle Diabetes Study Phase II.

Diabetes Research and Clinical Practice, *122*, 190–197. https://doi.org/10.1016/j.diabres.2016.10.023

Widom, C. S., Czaja, S. J., & Dutton, M. A. (2008). Childhood victimization and lifetime revictimization. *Child Abuse & Neglect*, *32*(8), 785–796. https://doi.org/10.1016/j.chiabu.2007.12.006

World Health Organization. (2017). *NCD mortality and morbidity*. http://www.who.int/gho/ncd/mortality_morbidity/en/

Yusuf, S., Hawken, S., Ôunpuu, S., Dans, T., Avezum, A., Lanas, F., Mcqueen, M., Budaj, A., & Pais, P. (2004). Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): Case-control study. *Lancet*, *364*, 937–952.

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

How to cite this article: Caceres, B. A. , Britton, L. E., Cortes, Y. I., Makarem, N., & Suglia, S. F. (2021). Investigating the associations between childhood trauma and cardiovascular health in midlife. *Journal of Traumatic Stress*, 1–15. https://doi.org/10.1002/jts.22752