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Authors

Lee, Chioun
Tsenkova, Vera
Carr, Deborah

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Childhood trauma and metabolic syndrome in men and women

Chioun Lee[a,*], **Vera Tsenkova**[b], and **Deborah Carr**[c]

[a]Office of Population Research, Princeton University, Princeton, NJ, USA

[b]Institute on Aging, University of Wisconsin-Madison, WI, USA

[c]Department of Sociology and Institute for Health, Health Care Policy & Aging Research, Rutgers University, New Brunswick, NJ, USA

Abstract

The long-term effects of childhood trauma on health are well-documented, but few population-based studies have explored how childhood trauma affects the risk of developing metabolic syndrome (MetS) in adulthood. Using data from 1,234 adults in the second wave of the Midlife Development in the U.S. survey (2004), we investigate (1) the extent to which childhood abuse affects the risk of developing MetS in adulthood; (2) how the severity of different types of abuse (emotional, physical, sexual, or cumulative abuse) affects this risk; and (3) the extent to which adult socioeconomic status (SES), maladaptive stress responses, and unhealthy behaviors mediate the association. We also test whether these associations differ significantly by sex. We find that emotional and physical abuse increase the risk of developing MetS for both sexes, whereas sexual abuse is a predictor for women only. For both sexes, individuals who experienced more cumulative abuse have a greater risk of developing MetS. Adult SES partially explains the association between childhood abuse and MetS. Maladaptive stress responses and unhealthy behaviors further explain the association. Among the potential mediators, poor sleep quality was a significant pathway for men and women, while stress-induced eating was a significant pathway for women only. Our findings suggest that the well-documented health consequences of early life trauma may vary by the nature of the trauma, the victim's sex, and the coping mechanisms that he or she employs.

Keywords

stress; childhood trauma; sex; metabolic syndrome; coping; life course

[*]**Corresponding author**: Chioun Lee, 261 Wallace Hall, Princeton NJ 08544, USA, Tel.: +1 609 258 1392, Fax: +1 609 258 1039, chiounl@princeton.edu.

Introduction

Metabolic syndrome (MetS) is a cluster of conditions—abdominal obesity, glucose intolerance, high blood pressure, and both low "good" and high "bad" blood cholesterol levels—which co-occur, heightening an individual's risk of cardiovascular disease (CVD), coronary heart disease (CHD), and stroke. Each of these disorders is among the leading causes of adult mortality in the U.S. (Ford, 2005). The MetS-related mortality rate and the costs of treatment have increased over the past three decades, burdening individuals and health care systems (Boudreau et al., 2009).

MetS typically emerges during adulthood, yet the risk of developing MetS is affected by social and economic factors in early life, such as childhood abuse (Danese & Tan, 2013; Riley et al., 2010). Most studies, however, have focused on either a single type of childhood abuse—physical, sexual, or emotional—or a single symptom of MetS, typically obesity. Moreover, most studies have not explored how the severity of abuse affects the risk of developing MetS. While many studies have documented sex differences in the type of abuse (Sedlak et al., 2010), relatively little attention has been given to sex differences in the impact of childhood abuse on the development of MetS. This omission is surprising given that the biological and psychosocial mechanisms (e.g., estrogen, depression, and stress-induced eating) associated with both childhood abuse and MetS differ by sex (Carr, 2003; Tanofsky et al., 1997). Documenting the proximate pathways linking childhood abuse to MetS and potential sex differences is important, as it may help inform sex-specific interventions to modify behaviors associated with MetS.

Using data from the Midlife Development in the U.S. study (MIDUS), we (1) investigate the association between childhood trauma and MetS in men and women and (2) evaluate the extent to which these associations are explained by social, psychological, and behavioral mechanisms. Our study contributes to the study of the long-term health effects of early life adversity by (1) showing how different types and severities of childhood trauma explain variation in adult health, (2) linking victims' potentially modifiable health conditions/ behaviors to adult health, and (3) identifying sex differences in these processes.

Childhood trauma and MetS

Over the past three decades, CHD has been the leading cause of death among adults in the U.S. (Jemal et al., 2005). MetS is one of the main contributors to CHD (Alberti et al., 2006). About 34% of U.S. adults met the criteria for MetS in the 2003−2006 National Health and Nutrition Examination Survey (Ervin, 2009). Individuals who have MetS are three to four times more likely to die of CHD, have a threefold greater risk of developing type 2 diabetes (Ford, 2005), and a twofold greater risk of all-cause mortality (Lakka et al., 2002).

Stressful life experiences during childhood increase the risk of chronic disease (Dong et al., 2004; Felitti et al., 1998). Evidence from prospective and cross-sectional studies links childhood trauma to an elevated risk of having some of the symptoms of MetS. Compared with non-victims, victims of childhood abuse are more likely to be obese, have hypertension, or have three or more symptoms of MetS, even after adjusting for

sociodemographic and health covariates (Danese et al., 2009; Danese & Tan, 2013; Riley et al., 2010).

Plausible pathways linking childhood trauma to MetS

SES

Childhood abuse may occur at all levels of SES, although higher rates have been documented in low-income and impoverished family environments, possibly due to increased exposure to stressful circumstances, including economic insecurity and substance abuse (Kelleher et al., 1994; Sedlak et al., 2010). Victims of abuse are at greater risk of poor educational outcomes, unemployment, and low adult SES, even after adjusting for childhood SES (Currie & Widom, 2010). Therefore, SES in adulthood might be a pathway linking childhood trauma to MetS. Childhood abuse might further heighten the risk of MetS through harmful stress responses, including poor sleep quality, depression, and anxiety.

Poor sleep quality

Sufficient sleep is essential to maintaining the body's homeostatic functions. Chronic sleep deprivation disrupts carbohydrate metabolism and endocrine function (Spiegel et al., 1999). Both sleep loss and poor sleep quality are associated with high BMI (Cautera et al., 2007), increased risk of receiving a diagnosis of MetS, and cumulative MetS symptoms (Bass & Turek, 2005; Jennings et al., 2007). Victims of childhood abuse often report sleep problems, including disturbed sleep and increased nocturnal activities (Bader et al., 2007). The adverse consequences of childhood abuse for sleep quality are more likely to emerge when individuals are exposed to severe and frequent abuse (Greenfield et al., 2011).

Depression and anxiety

Much research has focused on the relationship between mental health and chronic diseases. However, few studies have documented mental health pathways linking childhood abuse to MetS. Emerging literature suggests that depression is related to risk of diabetes (Goldbacher et al., 2009); a recent meta-analysis of cross-sectional and prospective cohort studies suggests a bidirectional relationship (Pan et al., 2012). Ethnographic studies using life history narratives show that among women seeking diabetes care, those who experienced childhood violence are more likely to have depression, which suggests a significant association between depression and diabetes, particularly for victims of childhood trauma (Mendenhall & Jacobs, 2012). The relationship between anxiety and MetS has received less attention, although some studies have documented a positive association (Carroll et al., 2009; Skilton et al., 2007).

Stress-induced eating

Maladaptive coping strategies, which are very common among victims of childhood abuse, might increase the risk of developing MetS (Mason et al., 2013). When faced with stressful situations, some individuals rely on techniques focused on soothing their emotional responses to stress; emotion-focused tactics include health-related behaviors, such as overeating (Lazarus & Folkman, 1984). Though consuming high-fat or high-sugar foods or eating more food than usual in response to stress may provide short-term emotional lifts

(Epel et al., 2001), these tactics may carry long-term negative health consequences that may explain why victims of childhood trauma are at greater risk of developing MetS (Greenfield & Marks, 2009). Abused children are more likely to become “emotional eaters” (i.e., eating to sooth negative emotions), a habit which might continue into adulthood (Kent et al., 1999).

Smoking, heavy drinking, and lack of exercise

Cigarette smoking, heavy drinking, and physical inactivity are associated with increased insulin resistance and metabolic abnormalities. Compared to those who have never smoked, current smokers have a greater risk of developing MetS (Park et al., 2003). While mild to moderate alcohol consumption is inversely associated with MetS, heavy drinking increases one’s risk of developing MetS (Lambropoulos et al., 2007). Lower levels of physical activity also increase the risk of developing MetS, possibly because of increased risk of abdominal obesity (Laaksonen et al., 2002). Given that those with a history of childhood abuse are more likely to engage in unhealthy behaviors (Kendall-Tackett, 2002), these behaviors might be potential routes through which victims later develop MetS.

Sex differences

We also assess the extent to which the effect of abuse on MetS, and the specific pathways that account for the association, vary by sex. The nature of childhood trauma differs by sex; for example, women are more likely to encounter sexual abuse (Sedlak et al., 2010), although this difference is partly attributable to men’s tendency to underreport such experiences (Holmes & Slap, 1998). Moreover, biological mechanisms may affect men and women in different ways. During young adulthood and early midlife, female hormones (e.g., estrogen) cause women to have lower blood pressure and less abdominal fat than men, which may help delay the onset of MetS until menopause; the gap between men and women narrows and even reverses after menopause (Carr, 2003).

We also expect that any behavioral and emotional responses to childhood trauma that potentially link abuse to MetS would differ by sex. For example, clinical studies have found positive associations between sexual abuse and stress-induced eating, which might be partially explained by psychological factors including mood disorder, behavioral impulsivity, and body image disturbance (Gustafson & Sarwer, 2004). Additionally, women are more likely than men to develop eating disorders (Tanofsky et al., 1997) and to report poorer sleep quality (Arber et al., 2009). Women’s compromised sleep quality has been attributed to biological and social factors including psychological symptoms, hormonal fluctuations across the life course (Dzajaa et al., 2005), and family caregiving (Burgard, 2011). Therefore, we expect the association between childhood trauma and MetS is stronger for women than men.

Data and methods

Sample

The analytic sample comes from the Biomarker Substudy of the Midlife Development in the U.S. survey (MIDUS), a longitudinal study of health and aging among individuals in the 48 contiguous states. MIDUS I (N = 7,108), which was conducted from 1995 to 1996, included

non-institutionalized, English-speaking individuals between 25 and 75 years old (b. 1920−1970). A follow-up (MIDUS II) was conducted 10 years after the baseline assessment for 4,963 MIDUS I respondents (70% response rate). To increase the total number of Black respondents in MIDUS, a sample of 592 African Americans from Milwaukee, Wisconsin was recruited to participate in the MIDUS II survey. Of those who responded to the questions in MIDUS II, 1,255 (23% of MIDUS II) were able and willing to participate in the time-intensive Biomarker Substudy. Compared to the other respondents in MIDUS II, those in the Biomarker Substudy had higher levels of education and income, visited doctors more frequently, and maintained an overall healthier lifestyle, but they were similar in terms of age, sex, and marital status (Love et al., 2010). The Biomarker Substudy was approved by the Health Sciences Institutional Review Boards at the University of Wisconsin-Madison, the University of California-Los Angeles, and Georgetown University.

Measures

Childhood Trauma—Early life trauma (up to age 18) was measured with 15 items of the Childhood Trauma Questionnaire (CTQ; Bernstein & Fink, 1998). The CTQ includes five items within each of three different domains: (1) *emotional abuse* (called names, felt unwanted, verbally abused, felt hated, and emotionally abused), (2) *physical abuse* (hit and medically treated, bruised, abuse noticed by others, punished with hard objects, physically abused), and (3) *sexual abuse* (touched sexually, sex used for control, forced exposure to sex, molested, and sexually abused). Response categories ranged from 1 (never true) to 5 (very often true). Possible total scores of each domain ranged from 5 to 25. Self-reported versions of the CTQ have good criterion-related validity, promote feelings of privacy, and are generally considered less invasive than being evaluated by face to face interviews (Bernstein et al., 2003).

We recoded continuous scores into categorical indicators of none, low, moderate, and severe abuse, following Bernstein and Fink's guidelines. Correlations between the three types of abuse ranged from .30 to .57 for men and from .40 to .67 for women. For both sexes, the strongest correlation was between emotional and physical abuse. The small number of individuals who experienced severe abuse raised concerns regarding statistical power (e.g., n = 17 for men with severe sexual abuse). Hence, we collapsed the moderate and severe abuse groups. We also created a measure for the total score of all three types of abuse—*cumulative abuse*—which ranged from 0 (no abuse) to 9 (severe abuse in all three domains).

Metabolic Syndrome *(MetS)*—We used the definition of metabolic syndrome that is currently in use by the National Cholesterol Education Program−Third Adult Treatment Panel (NCEP−ATP III), which includes at least three of the following five conditions (National Institute of Health, 2001): (1) abdominal obesity (waist circumference > 102 cm in men and > 88 cm in women); (2) high blood pressure (systolic pressure ≥ 130 mm Hg, diastolic pressure ≥ 85 mm Hg or treatment with antihypertensive medications); (3) elevated triglyceride levels (≥ 1.7 mmol/L); (4) elevated fasting glucose (>100 mg/dL or treatment with anti-diabetic medications); and (5) low high-density lipoprotein (< 40 mg/dL in men and < 50 mg/dL in women). We created two measures of MetS: (1) *MetS diagnosis*: a dichotomous measure indicating whether the participant meets the NCEP definition of MetS

(three or more symptoms) and (2) *MetS symptoms*: a continuous measure indicating one's total number of MetS symptoms (0 through 5).

Potential Mediators

We used two measures for adult SES: (1) *education* (less than high school, high school, college, more than master's degree) and (2) *financial difficulties*, with potential responses ranging from 1 (not at all difficult to pay monthly bills) to 4 (very difficult).

Sleep quality—The Pittsburgh Sleep Quality Inventory (Buysse et al., 1989) includes seven sleep components: subjective quality, latency, duration, habitual sleep efficiency, disturbance, use of sleep medications, and daytime dysfunction. Responses to items for each component may range from 0 to 3, with higher scores indicating poorer subjective sleep quality. We used a summary index of the seven sleep components, ranging from 0 to 21. *Depressive symptoms* were assessed using the 20-item Center for Epidemiological Studies Depression Inventory (CES-D; Radloff, 1977). Respondents were asked to rate the presence and duration of each item over the past week, using a 4-point scale from 0 (rarely or never) to 3 (most or all of the time). *Anxiety symptoms* were assessed using the 20-item State–Trait Anxiety Inventory (STAI; Spielberger, 1983), which was developed to provide reliable, brief, self-report scales for assessing anxiety (Spielberger, 1983). Responses were based on a 4-point scale ranging from 1 (almost never) to 4 (almost always). Average internal consistency (Cronbach's alpha) for these 20 items was .89 for CES-D and .90 for STAI. *Stress-induced eating* items asked respondents to indicate how they "usually experience a stressful event." Two options were "I eat more of my favorite foods to make myself feel better" and "I eat more than I usually do." Responses ranged from 1 (a lot) to 4 (not at all). The correlation between the two items was .79. Responses were reverse-coded and averaged so that higher scores indicate greater levels of stress-induced eating. We also included three health behaviors: (1) *smoking* (never smoked, former smoker, or current smoker), (2) *alcohol use* (never, moderate [two or fewer days per week], or frequent [three or more days per week]), and (3) *lack of exercise* (less than three 20-minute sessions per week).

Control Variables—We used four control variables: (1) race/ethnicity (non-Hispanic white vs. other race groups), (2) age (range: 34–84), (3) highest level of parental education (less than high school, high school, more than high school), and (4) marital status (married/cohabiting vs. other categories).

Analytic Strategy

The analysis has three parts. First, we conducted bivariate analyses to contrast men's and women's scores on all measures. Second, to identify the association between childhood trauma and MetS, we estimated OLS models for MetS symptoms and logistic regression models for MetS diagnosis. We adjusted all control variables (model 1) and presented the number of MetS symptoms (Figure 1) and the probability of having a MetS diagnosis (Figure 2) by sex and severity of each type of childhood trauma. In Table A1, we present the adjusted probability of having each MetS symptom. Third, for mediation analysis, we first evaluated the extent to which adult SES explains the association between childhood trauma and MetS (model 2). We then investigated the extent to which maladaptive stress responses/

unhealthy behaviors further explain the association (model 3). Anxiety is excluded from the final model because (1) it is strongly correlated with depressive symptoms (r = .80), (2) it is not significantly associated with MetS, and (3) including it does not yield significant model improvement.

We assessed the contribution of the mediators by (1) calculating percentage changes of coefficients between the models (see Table 2A in the Appendix) and (2) comparing the significance levels of childhood trauma coefficients between the models. We used the full model to determine which mediators significantly linked *cumulative abuse* and MetS. Bootstrapping was used to accurately calculate the standard error of the mediation effect and report bias-corrected 95% confidence intervals (Hayes, 2009; MacKinnon, 2008).

Given gender differences in the risk of experiencing each type of abuse and of developing MetS, we directly assessed whether the association between childhood trauma and MetS differs by sex, by pooling data from both sex and testing two-way interaction terms. There was item-specific missing data for approximately 15% of the respondents. We imputed missing data on the independent variables under the missing-at-random assumption (Allison, 2001). After excluding 21 respondents with missing information for at least one MetS symptom, the final analytic sample included 534 men and 700 women.

Results

Descriptive statistics

Table 1 presents descriptive statistics by sex. Women were more likely than men to experience emotional abuse and sexual abuse, and they had higher levels of cumulative abuse, but there was no sex difference in physical abuse. Women reported higher levels of anxiety, depressive symptoms, sleep quality, stress-induced eating, and lower levels of exercise. Even after adjusting for age, women had fewer symptoms of MetS (1.85 vs. 2.27, $p < .001$) and were less likely to have a MetS diagnosis (31% vs. 44%, $p < .001$).

Does childhood trauma increase risk of developing MetS for men and women?

Figures 1 and 2 show the adjusted number of MetS symptoms and probability of MetS diagnosis by sex and by the severity of each type of childhood trauma. There are four notable patterns. First, compared with non-victims, victims of moderate/severe trauma have more MetS symptoms and a greater risk of having a MetS diagnosis. Second, among men, an increase in the severity of emotional and physical abuse, but not sexual abuse, is associated with an increase in the number of MetS symptoms. Third, among women, an increase in the severity of abuse is not uniformly associated with a higher risk of having a MetS diagnosis or more MetS symptoms. For example, regardless of the severity of abuse, the risk of having a MetS diagnosis is similar between the low (36%) and moderate/severe (38%) emotional abuse groups. Finally, women (but not men) who experienced moderate/severe sexual abuse have more MetS symptoms than women who were not sexually abused.

The effects of childhood abuse—in particular, physical, emotional, and cumulative abuse—are larger for men than women, whereas the effect of sexual abuse on MetS is larger for women. However, formal moderation analyses revealed that the magnitude of these

differences is not statistically significant. The non-significant interactions may reflect low statistical power, given the small number of respondents who experienced moderate/severe childhood trauma.

Potential mechanisms linking childhood trauma to MetS

The regression models presented in Tables 2 and 3 reveal the extent to which adult SES (model 2) and harmful stress responses/unhealthy behaviors (model 3) explain the association between each type of childhood trauma and MetS. Among men, those in the moderate/severe emotional abuse group have a greater risk of developing MetS than those in the no emotional abuse group. Including adult SES attenuates the difference between these two groups by 3−7%. Harmful stress responses and unhealthy behaviors further reduce the difference by 18–20%. Including all potential mediators reduces the disparity by 21–26%. The significance levels of the coefficients of emotional abuse are reduced from model 1 to model 3 for both MetS symptoms and MetS diagnosis. For women there is no significant difference in the number of MetS symptoms between the no abuse group and the emotional abuse groups, yet moderate/severe emotional abuse increases the risk of being diagnosed with MetS. After including adult SES, the disparity declines by 22%, eliminating any significant differences between the two groups.

For men, those in the moderate/severe physical abuse group have more MetS symptoms than those in the no physical abuse group and are more likely to have a diagnosis of MetS. Controlling for adult SES reduces the disparity between these two groups by 3–6%, and adding harmful stress responses/unhealthy behaviors further reduces the disparity by an additional 9–13%. After accounting for all mediators, the disparity between groups declines by 11–19%, yet remains significant. For women, compared with the no physical abuse group, the moderate/severe physical abuse group has an elevated number of MetS symptoms and a higher risk of having a MetS diagnosis. Accounting for all mediators reduces the disparity between the two groups by 33–40%, eliminating any significant group differences.

Though sexual abuse is not a significant predictor of MetS for men, women who experienced moderate/severe sexual abuse have more MetS symptoms than those in the no sexual abuse group. The effect of sexual abuse on MetS declined by 14% after accounting for adult SES and was no longer statistically significant.

Cumulative abuse is positively associated with both number of MetS symptoms and risk of having a MetS diagnosis for both sexes. Taking adult SES into account significantly attenuates the effects of cumulative abuse on MetS for both men and women (4–18%). Adding harmful stress responses/unhealthy behaviors further decreases the effects for both sexes (20–43%). After accounting for all mediators, cumulative abuse is not significantly associated with risk of having a MetS diagnosis for either sex, and it is not significantly associated with the number of MetS symptoms for women. In sum, although adult SES partially explains the association between childhood trauma and MetS, harmful stress responses/unhealthy behaviors further explain the association.

We used the full model to test the mediated effects for significance (not shown). For women, poor sleep quality and stress-induced eating significantly link cumulative abuse and risk of

having a diagnosis of MetS. About half of the total effects are mediated by two variables—24% for poor sleep quality (95% CI = .003–.066) and 25% for stress-induced eating (95% CI = .013–.056). For men, sleep quality explains 20% of the association between cumulative abuse and risk of having a MetS diagnosis (95% CI = .003–.067).

Discussion

Our study is the first that we know of that assesses the effects of specific types of childhood abuse on two measures of MetS, identifies specific psychosocial and behavioral pathways accounting for these associations, and evaluates sex differences in these patterns. Several key contributions emerge from our findings. First, childhood trauma increases both the number of MetS symptoms and the risk of having a MetS diagnosis. Our findings are consistent with prior studies documenting an association between childhood trauma and increased risk of having three or more MetS symptoms (Danese et al., 2009) or a single symptom of MetS (Danese & Tan, 2013; Riley et al., 2010; Rohdea et al., 2008). While most prior studies used obesity as a sole outcome, we use the five comprehensive measures of MetS outlined by the NCEP−APT III and find that childhood trauma is associated with a MetS diagnosis as well as the number of MetS symptoms.

Second, risk of developing MetS varies by the type of childhood trauma and by sex. Emotional and physical abuse increase the risk of MetS for both sexes, while sexual abuse only affects women. Our findings are consistent with prior studies in which sexual abuse was found to increase the risk of obesity and hypertension for middle-aged women (Riley et al., 2010; Rohdea et al., 2008). There may be several reasons why sexual abuse did not increase men's risk of MetS. First, the CTQ measure may not accurately capture men's experiences of sexual abuse because it aims to detect abuse within the home, whereas boys are more likely to experience sexual abuse in non-domestic relationships (Holmes & Slap, 1998). Second, cultural norms such as hegemonic masculinity encourage men to take on a dominant role in their sexual relationships; the stigma against submissiveness and same-sex sexual contact might make men reluctant to report abuse by other men (Holmes & Slap, 1998). Finally, the lack of statistical power, due to the small number of men who reported experiencing sexual abuse, might also explain the non-significant effect of sexual abuse on MetS. Given the public's increasing awareness of male sexual abuse and its consequences, future research should test whether our findings hold for younger cohorts, for whom the stigma and shame of abuse may be less profound.

Our third key finding is that the severity of childhood trauma helps explain the risk of developing MetS. As severity of abuse increases, the number of MetS symptoms increases, particularly for men. Prior studies have found that severe forms of childhood trauma increase the risk of developing obesity and hypertension (Greenfield & Marks, 2009; Riley et al., 2010), although they did not distinguish between different types of abuse. Fourth, we detected sex differences in the nature of childhood trauma, the risk of developing MetS, and coping strategies in response to stress. Moderate/severe forms of emotional and physical abuse were more likely to increase the risk of developing MetS for men than for women, whereas moderate/severe sexual abuse increased the risk for women but not for men.

However, these differences were not statistically significant in formal moderation analyses, perhaps due to small cell sizes.

Contrary to our expectations, the association between childhood trauma and MetS is weaker for women than men. Women's lower risk of developing MetS may stem from the biological advantages of female hormones (Janssen et al., 2008). Even among those who are post-menopausal, some may have received hormone treatments which help delay the onset of MetS (Lobo, 2008). We speculate that the risk of developing MetS might increase as women age and that both biological (e.g., a decline in female hormones) and psychological (e.g., an increase in depressive symptoms) factors may contribute to this relationship. Given that only a subset of the women in MIDUS were asked about menopause status and hormonal therapy, we did not examine whether these factors influenced the effects of childhood abuse on MetS. We encourage future studies to examine the association.

Finally, sleep problems significantly mediates the association between childhood trauma and MetS for both sexes, while stress-induced eating mediates the association only for women. Sleep problems may be more salient than other mediators for both sexes because of its reciprocal relation with other health risk behaviors. Poor quality and insufficient sleep are associated with heightened food consumption, depressive symptoms, obesity, and alcohol use (e.g., Hayashino et al., 2010). Therefore, improving sleep quality might reduce the risk of developing MetS by eliminating the risk of unhealthy behaviors.

Limitations and future directions

Our study has several limitations. First, given the cross-sectional nature of the biomarker data, we cannot definitively ascertain the causal ordering between purported mediators and MetS. We do not have information regarding sleep quality or stress-induced eating during childhood, and we assume that adult indicators are reasonable proxies for health behaviors that may have developed decades earlier. Even though research has consistently documented that sleep problems precede MetS, a handful of studies demonstrate reverse causality (Foley et al., 2004). To better understand the direction of causality between mediators and MetS, future studies should use prospective multi-wave data collected at various times throughout childhood and adulthood.

Second, child abuse reports are retrospective and potentially susceptible to both recall bias and other perceptual biases. Individuals with current mood disorders might exaggerate or misrepresent their adverse experiences during childhood (White et al., 2007). Nonetheless, recent studies report that memories of specific childhood experiences are highly stable (Yancura & Aldwin, 2009) and delayed recollections of traumatic events, such as childhood abuse, are fairly accurate (Hardt & Rutter, 2004). In supplementary analyses, we also found a strong correlation between reports of physical abuse at MIDUS I and MIDUS II (Cohen's kappa = 84.5%). Given that the retrospective reports were collected 10 years apart, the measures of self-reported childhood abuse in this study are quite reliable. Nonetheless, our suggestions that future researchers examine data collected from childhood through adulthood would reduce the potential for recall bias.

Third, unobserved or omitted factors might explain more of the variation in the associations between childhood trauma and MetS. For example, psychiatric disorders, such as post-traumatic stress disorder (PTSD), may increase the risk of developing MetS for victims of childhood trauma. Recent studies have indicated that among veterans, greater severity of PTSD is associated with increased risk of MetS (Heppner et al., 2009). In addition, victims of childhood abuse might adopt other coping strategies which may affect their risk of developing MetS. For example, avoidance/distraction strategies like blunting may be helpful to reduce stress in the immediate aftermath of uncontrollable situations like childhood abuse, but the benefits from blunting might not endure given that the memories of abuse can persist into adulthood (Suls & Fletcher, 1985). Prior studies have found that avoidance is a commonly reported coping strategy among sexually abused children and that it is a potential mediator that links sexual abuse to mental health problems (Bal et al., 2003). Exposure to child abuse is strongly correlated with intimate partner violence in adulthood (Anderson, 2010). Therefore, a greater risk of MetS might be explained by other types of family violence or later life trauma beyond childhood. We could not address these concerns due to data limitations of MIDUS; however, we suggest that future studies consider using such measures.

Other characteristics of childhood abuse—such as the timing of exposure and the victim's relationship with the perpetrator—are important factors in determining victims' health outcomes. Experiencing violence during childhood at the hands of a biological parent—the most common perpetrators (Kelleher et al., 1994; Sedlak et al., 2010)—can have long-term negative consequences on health, possibly through failure to develop psychological strength from the parent–child bond (Bowlby, 1988). The MIDUS II survey did not include such detailed information. Future studies should consider how these factors affect the risk of developing MetS among victims of trauma.

Finally, prior research has indicated that victims of childhood trauma are more likely to exit panel studies between midlife and later life, possibly due to greater risk of mortality or morbidity (Springer, 2009). Our supplementary analyses show that respondents with a history of severe physical abuse were more likely to die between MIDUS I and MIDUS II. Therefore, non-random attrition for abused individuals might affect the strength of the association between childhood trauma and risk of developing MetS, particularly for older adults. However, due to the cross-sectional nature of the biomarker data, it is difficult to investigate the extent to which such differential attrition biased the association.

Despite these limitations, the finding that childhood trauma is associated with increased risk of Mets helps advance our understanding of the early life foundations of MetS in adulthood. Documenting the proximate, and potentially modifiable, factors that link early life abuse with adult MetS is crucial for preventing disorders related to MetS. Our results suggest that interventions should consider both the nature of early life trauma and its consequences on psychobehavioral factors. When healthcare providers counsel victims of childhood abuse, they should consider the long-term psychological and physical wellbeing of victims. Early intervention is crucial for countering adverse responses to abuse—such as disordered eating, sleeping problems, and depressive symptoms—and promoting healthier ways to cope with

trauma. Such early psychological interventions would have the potential to prevent physical health problems in later life.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Highlights

- We examine whether childhood trauma affects the risk of developing metabolic syndrome (MetS).
- Childhood trauma is measured by retrospective self-reported emotional, physical, and sexual abuse up to age 18.
- Emotional, physical, and cumulative abuse are associated with increased risk of MetS for both sexes.
- Sexual abuse is associated with increased risk of MetS for women only.
- Poor sleep quality links childhood trauma to MetS for both sexes.

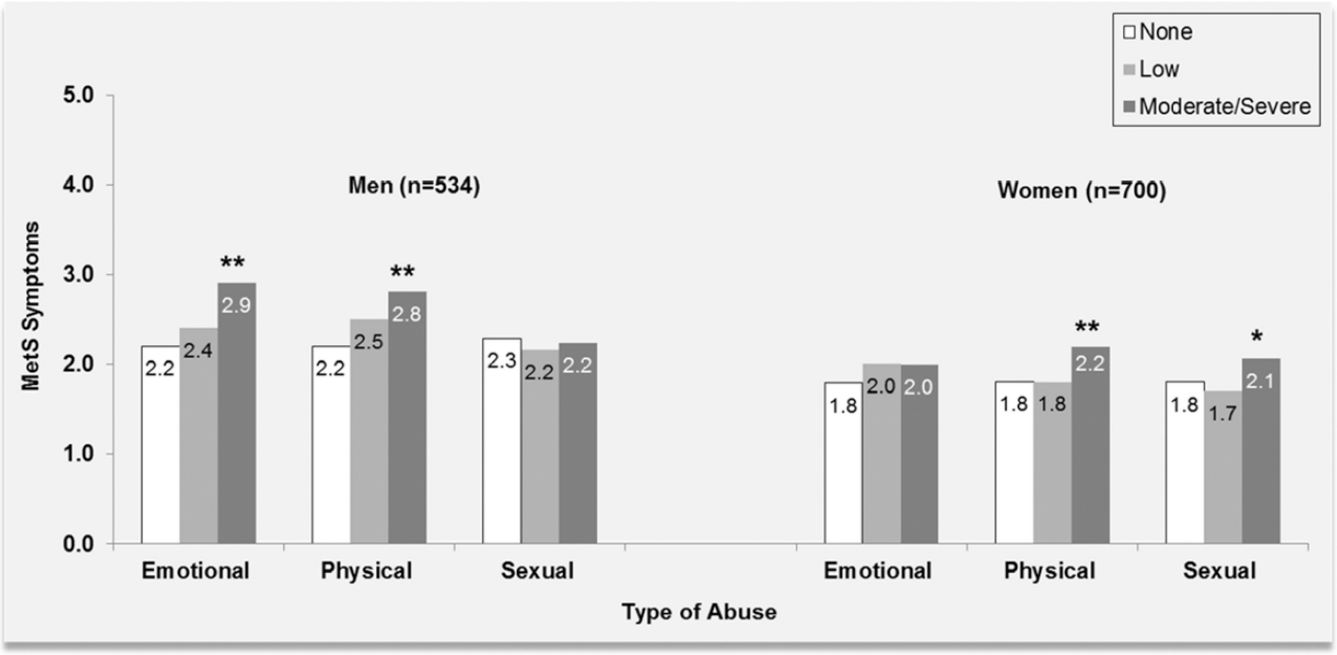

Figure 1.

Adjusted number of metabolic syndrome (MetS) symptoms, by sex and by type and severity of childhood trauma

Note: Age, race/ethnicity, marital status and parental education are adjusted. *P*-value indicates a significant difference between none (reference) and other severities of abuse. * $p < .05$; ** $p < .01$.

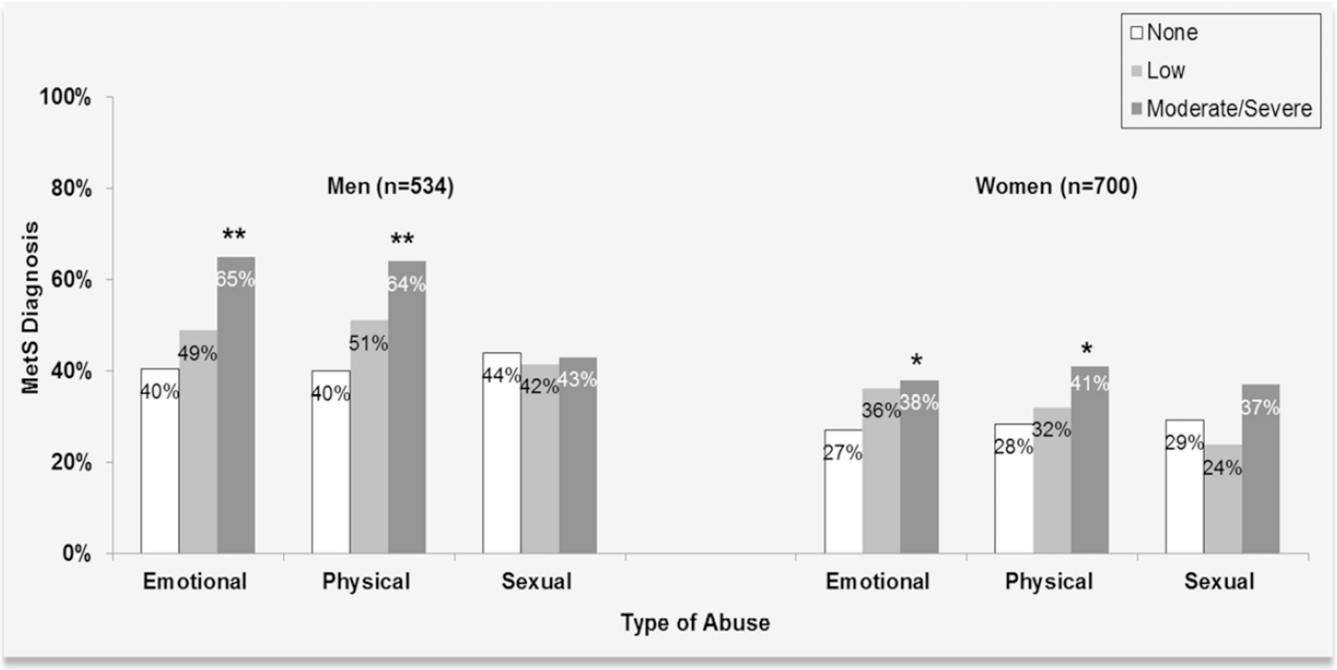

Figure 2.

Adjusted probability of having a metabolic syndrome (MetS) diagnosis, by sex and by type and severity of childhood trauma

Note: Age, race/ethnicity, marital status, and parental education are adjusted. *P*-value indicates a significant difference between none (reference) and other severities of abuse. * $p < .05$; ** $p < .01$.

Table 1

Descriptive statistics for all variables used in analysis, by sex, MIDUS II (2004–2009)

Variable (observed range) Mean (SD) or Proportion (n)	Men (n = 534)	Women (n = 700)
Childhood trauma		
Emotional abuse		
None	75 (399)	64 (450)
Low	18 (95)	18 (126)
Moderate/Severe	5 (40)	18 (124)
Physical abuse		
None	78 (415)	76 (530)
Low	11 (61)	9 (66)
Moderate/Severe	11 (58)	15 (104)
Sexual abuse		
None	87 (462)	68 (475)
Low	5 (28)	9 (61)
Moderate/Severe	8 (44)	23 (164)
Cumulative abuse (0–9)[a]	1.00 (1.73)	1.78 (2.45)
Metabolic syndrome		
Diagnosis	44 (234)	31 (217)
Total number of symptoms (0–5)	2.28 (1.36)	1.85 (1.39)
Potential mediators		
Adult SES		
Education		
High school or less	24 (127)	32 (222)
Some college	15 (81)	20 (137)
Bachelor's degree	38 (205)	28 (195)
Master's degree or more	23 (121)	21 (146)
Financial difficulties (1–4)[b]	1.89 (.88)	2.11(.98)
Harmful stress responses		
Sleep problems (0–19)	5.71 (3.40)	6.62 (3.83)
Depressive symptoms (0–54)	8.20 (7.82)	9.23 (8.55)
Anxiety symptoms (20–71)	33.23 (8.65)	35.27 (9.34)
Unhealthy behaviors		
Stress-induced eating (1–4)[c]	1.65 (.78)	2.09 (1.00)
Smoking history		
Never smoked	48 (254)	56 (395)
Past smoker	36 (192)	30 (210)
Current smoker	17 (88)	14 (95)
Weekly alcohol use		
Never	29 (155)	39 (276)
Moderate	40 (211)	45 (317)

Variable (observed range) Mean (SD) or Proportion (n)	Men (n = 534)	Women (n = 700)
Frequent	31 (168)	15 (107)
Lack of exercise	80 (429)	86 (601)
Control variables		
Age (34–84)	55.13 (11.93)	54.03 (11.53)
Race/ethnicity (white)	83 (445)	75 (526)
Parental education		
Less than high school	24 (127)	27 (192)
High school	38 (201)	31 (216)
More than high school	39 (206)	42 (292)
Married/cohabiting	76 (406)	56 (395)

Note:

[a] Cumulative abuse ranges from 0 (no abuse in any domain) to 9 (severe abuse in all three domains).

[b] Financial difficulties range from 1 (not at all difficult) to 4 (very difficult).

[c] Stress-induced eating ranges from 1 (never) to 4 (often).

Table 2

Coefficients (standard error) from linear regression model predicting MetS symptoms for men (n = 534) and women (n = 700).

	Men			Women		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Emotional Abuse						
Low	.21 (.16)	.18 (.15)	.07 (.16)	.18 (.14)	.16 (.14)	.10 (.13)
Moderate/Severe	.72** (.22)	.67** (.23)	.54* (.23)	.22 (.14)	.15 (.14)	.01 (.14)
Physical Abuse						
Low	.30 (.19)	.27 (.19)	.32 (.18)	−.01 (.18)	−.02 (.18)	−.05 (.17)
Moderate/Severe	.62** (.19)	.58** (.19)	.51** (.19)	.40** (.15)	.36* (.15)	.24 (.15)
Sexual Abuse						
Low	−.09 (.27)	−.10 (.26)	−.13 (.26)	−.15 (.19)	−.16 (.18)	−.17 (.18)
Moderate/Severe	−.06 (.21)	−.07 (.21)	−.12 (.21)	.26* (.12)	.22 (.13)	.15 (.12)
Cumulative abuse[a]	.10** (.03)	.09** (.03)	.07* (.03)	.06* (.02)	.05* (.02)	.03 (.02)

Note: Model 1 is adjusted for age, race/ethnicity, parental education, and marital status; Model 2 is adjusted for education and financial difficulties in addition to variables in Model 1. Model 3 is adjusted for sleep problems, stress-induced eating, depressive symptoms, smoking, drinking alcohol, and lack of exercise in addition to variables in Model 2.

[a] Cumulative abuse ranges from 0 (no abuse in any domain) to 9 (severe abuse in all three domains).

* $p < .05$;

** $p < .01$;

*** $p < .001$

Table 3

Odds ratios (95% CI) from logistic regression model predicting MetS diagnosis for Men (n = 534) and Women (n = 700).

	Men			Women		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Emotional Abuse						
Low	1.45 (.92–2.28)	1.41 (.89–2.23)	1.19 (.72–1.93)	1.53 (1.00–2.34)	1.47 (.96–2.67)	1.36 (.86–2.14)
Moderate/Severe	2.77** (1.39–5.52)	2.68** (1.33–5.36)	2.24* (1.07–4.68)	1.65* (1.07–2.54)	1.48 (.95–2.30)	1.30 (.80–2.11)
Physical Abuse						
Low	1.56 (.89–2.71)	1.51 (.87–2.64)	1.64 (.92–2.92)	1.16 (.66–2.04)	1.15 (.66–2.02)	1.15 (.64–2.05)
Moderate/Severe	2.67** (1.50–4.76)	2.60** (1.45–4.67)	2.40** (1.29–4.44)	1.78* (1.14–2.78)	1.64* (1.04–2.59)	1.47 (.90–2.41)
Sexual Abuse						
Low	.94 (.43–2.05)	.93 (.43–2.03)	.85 (.38–1.92)	.76 (.41–1.42)	.76 (.41–1.42)	.71 (.37–1.37)
Moderate/Severe	.95 (.51–1.78)	.95 (.50–1.79)	.84 (.43–1.63)	1.42 (.97–2.08)	1.33 (.91–1.96)	1.20 (.79–1.82)
Cumulative abuse[a]	1.15** (1.04–1.28)	1.14* (1.03–1.27)	1.11 (1.00–1.24)	1.09** (1.02–1.17)	1.08* (1.01–1.15)	1.05 (.98–1.14)

Note: Model 1 is adjusted for age, race/ethnicity, parental education, and marital status; Model 2 is adjusted for education and financial difficulties in addition to variables in Model 1. Model 3 is adjusted for sleep problems, stress-induced eating, depressive symptoms, smoking, drinking alcohol, and lack of exercise in addition to variables in Model 2.

[a] Cumulative abuse ranges from 0 (no abuse in any domain) to 9 (severe abuse in all three domains).

* $p < .05$;

** $p < .01$;

*** $p < .001$