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Childhood Abuse is Associated with Adiposity in Mid-life Women: Possible Pathways through Trait Anger and Reproductive Hormones

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Abstract

Objective—To examine the association between childhood abuse/neglect and central adiposity and obesity in a sample of 311 women (106 Black, 205 White) from the Pittsburgh site of the Study of Women's Health Across the Nation (SWAN).

Methods—SWAN included a baseline measurement of women in midlife (mean age = 45.7) and 8 follow-up visits during which waist circumference (WC) and body mass index (BMI) were measured. The Childhood Trauma Questionnaire retrospectively assessed emotional, physical, and sexual abuse and emotional and physical neglect in childhood.

Results—ANCOVA analyses showed that women with a history of any abuse/neglect, and specifically physical and sexual abuse, had significantly higher WC and BMI at baseline than women with no abuse history. A significant interaction between abuse and BMI showed that among women with BMI < 30, any abuse/neglect and certain subtypes of abuse predicted greater increases in WC over time. Additional analyses showed that Trait Anger scores and sex hormone-binding globulin (SHBG) attenuated cross-sectional relationships between abuse/neglect and WC and BMI.

Conclusion—This study suggests that abused/neglected women appear to have greater anger and lower levels of SHBG, which are associated with adiposity in mid-life.

Keywords

abuse; neglect; adiposity; obesity; women; anger

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Introduction

Childhood abuse and neglect have devastating consequences. A recent review of reports on the cumulative prevalence rates of childhood abuse/neglect suggested that 5-35% of children experience physical abuse, 5-30% sexual abuse, 4-10% emotional abuse, and 6-12% neglect (1). It is well established that childhood abuse/neglect is a risk factor for poor mental health (2,3), and some studies have recently found associations with poor physical health (4-6). One such negative physical health outcome is obesity. Prospective studies showed that childhood physical neglect and sexual abuse were related to being obese in young adulthood (7-9), and physical abuse was related to obesity in middle-age (10).

Another deleterious health outcome of childhood abuse/neglect may be central adiposity. Central adiposity, defined as the deposition of body fat around the abdomen, has been shown to predict all-cause mortality and cardiovascular disease-related mortality (11,12). Additionally, central adiposity, independent of weight, is associated with other risk factors for disease such as type II diabetes, hypertension, and increased plasma triglycerides (13-15). The only study to explore the relationship between childhood abuse/neglect and central adiposity found that retrospective reports of verbal abuse, physical abuse, humiliation, and physical neglect were positively associated with WC in adulthood (16). However, as is the case in many studies assessing childhood abuse/neglect, Thomas et al. relied on a single question to determine a history of each type of abuse or neglect and no reliability or validity data for their assessment of childhood abuse/neglect were reported.

There are several potential pathways that may help explain the relationship between childhood abuse/neglect and adiposity. Abused/neglected children may engage in multiple negative health behaviors such as cigarette smoking, high alcohol intake, low levels of physical activity, or unhealthy dietary patterns, and all of which have been associated with high adiposity (17-19). Maltreated children may experience high levels of negative emotions, such as depression, anger, anxiety, and cynicism, and these emotions have been associated with adiposity (20-23). A third pathway may be that during the pubertal transition, abused/neglected children have disrupted regulation of reproductive hormones, and reproductive hormones are associated with increased adiposity during mid-life and the menopausal transition. Specifically, increases in central adiposity have been related to increases of free testosterone and follicle-stimulating hormone (FSH) and decreases of estradiol (24,25). Additionally, lower levels of sex hormone binding globulin (SHBG), which binds to reproductive hormones, have been associated with greater central adiposity (26).

The objective of this study was to examine the association between childhood abuse/neglect and adiposity in a sample of Black and White middle-aged women. We hypothesized that women with a history of any abuse/neglect would have higher WC and BMI at baseline, compared to non-abused/neglected women. Based on associations found in the empirical obesity literature, we hypothesized that the most harmful types of abuse/neglect for adiposity and obesity outcomes would be emotional abuse, physical abuse, sexual abuse, and physical neglect. Additionally, the literature suggests that BMI increases at a significantly steeper rate in young adulthood among abused females than non-abused comparison subjects (9). Thus, we hypothesized that women reporting any abuse/neglect, as well as those reporting specific subtypes of abuse/neglect except for emotional neglect, would have greater increases in central adiposity and obesity across time. Because BMI and WC were strongly correlated in the present sample, we explored whether abuse/neglect was related to WC at varying levels of BMI. Finally, we explored whether negative health behaviors, negative emotions, or reproductive hormones mediated relationships between abuse/neglect history and outcomes of adiposity and obesity. Understanding the relationship between childhood abuse/neglect and adiposity is important to help identify individuals at risk for cardiovascular disease and obesity.

Additionally, understanding the mechanisms that may link early-life victimization to adulthood health will help target pathways for early intervention.

Method

Participants

The present study was conducted using data from participants in the Study of Women's Health Across the Nation (SWAN), a multi-site, community-based, cohort investigation of menopause and aging. The sample included participants that enrolled in the Mental Health Study at the Pittsburgh SWAN site, which was designed to collect detailed mental health measures at baseline and over 9 years of follow-up visits. Participants were eligible for inclusion in the study if they were 42 to 52 years old, premenopausal or early perimenopausal, not using hormone therapy or oral contraceptives, had not undergone a hysterectomy or bilateral oophorectomy, and not pregnant or breast-feeding. All instruments and study protocol were approved by the University of Pittsburgh Institutional Review Board, and written informed consent was obtained from all participants.

Of the 463 Pittsburgh SWAN participants eligible for the Mental Health Study, 96% enrolled ($n = 443$). The Mental Health Study retention rate was approximately 82% through visit 9 ($n = 365$). Twenty-three participants did not complete the Childhood Trauma Questionnaire (CTQ), which was administered at visit 8 only. To be included in the present analysis, women had to have completed the CTQ and have anthropometric measures at visit 8, or within one year of visit 8. The final sample used in this study included 311 women (106 Black, 205 White).

Procedure

SWAN and Mental Health Study baseline assessments were conducted in 1996 and 1997. Core SWAN data from baseline through study visit 9 and Mental Health Study data from baseline through study visit 9 were available for analysis for the present study. SWAN participants completed self-administered and interviewer-administered questionnaires and a physical examination at the SWAN baseline and annually thereafter.

Measures

Anthropometric Indices—Standardized protocols were used by trained personnel who were certified by the coordinating center to measure weight, height, and WC. WC was measured in centimeters at the level of the natural waist, defined as the narrowest part of the torso as seen from the anterior aspect. In cases where a waist narrowing was difficult to identify, the measurement was taken at the smallest horizontal circumference in the area between the ribs and the iliac crest. Weight was measured without shoes, and in light indoor clothing, using a portable digital scale or a balance beam scale, depending on location of the visit. Portable scales were calibrated weekly and stationary clinic scales were calibrated monthly. Height was measured without shoes using either a metric folding wooden ruler, measuring tape, or a fixed stadiometer, depending on location of the visit. BMI was calculated as weight (kg)/height (m^2). Both WC and BMI were measured during the baseline and 9 annual SWAN examinations. There was a strong correlation between visit 8 WC and BMI ($r = .92, p < .001$). Cross-sectional analyses used WC or BMI at baseline. Longitudinal changes in WC and BMI were computed as the difference between baseline and visit 8 because the measure of childhood abuse/neglect was given at visit 8. Visit 7 data were used if visit 8 data were not available, and visit 9 data were used if visit 7 data were not available.

Childhood Abuse and Neglect—Childhood abuse and neglect were assessed using the 28-item short form of the Childhood Trauma Questionnaire (CTQ; 27), a self-report instrument that assesses emotional abuse (5 items), physical abuse (5 items), sexual abuse (5 items),

emotional neglect (5 items), and physical neglect (5 items). The CTQ also contains a three item Minimization/Denial subscale that was not used in analyses. Subjects rated statements about childhood experiences on five-point Likert-type scales (“never true” to “very often true”). Most items were phrased in objective and behavioral terms (e.g., “When I was growing up, someone touched me in a sexual way or made me touch them”), whereas some items required subjective evaluation (e.g., “When I was growing up, I believe I was sexually abused”). Abuse/neglect items were summed to yield scores on five subscales (emotional abuse, physical abuse, emotional neglect, physical neglect, and sexual abuse) with scores ranging from 5 to 25. Clinical cut-off points have been validated and have sensitivity and specificity at 0.85 or higher relative to clinical interview (therapists' ratings of childhood maltreatment) (27-29). Scores for each scale that were at or above these thresholds were classified as positive for abuse or neglect: emotional abuse = 10, physical abuse = 8, sexual abuse = 8, emotional neglect = 15, and physical neglect = 8. Scores at or above the clinical threshold on any one subscale, individuals were classified as having been exposed to any abuse or neglect. If scoring below all clinical cut-off points, an individual was classified as not exposed to abuse or neglect. The CTQ has strong test-retest reliability and convergent validity with clinical interview and therapist ratings (28, 30). Responses from SWAN participants showed that the CTQ had strong internal consistency, Cronbach's $\alpha = 0.70-0.94$ for the subscales in this investigation. The CTQ was given at visit 8.

Possible Mediators

Cigarette Smoking—Cigarette smoking was assessed by the item, “Since your last study visit, have you smoked cigarettes regularly (at least one cigarette a day)?” A positive response to this item indicated a current smoker. Analyses used smoking status measured at baseline.

Physical Activity—Physical activity questions were adapted from the Kaiser Physical Activity Survey, which was originally adapted from the Baecke physical activity questionnaire (31,32), and assessed physical activity in three domains: 1) household and care giving, 2) sports and exercise, and 3) active living. The time frame for the activity assessment was the past year. The physical activity score used for the present study was a summary score of the three different domains, and the scale was reverse coded so that high scores indicated low levels of physical activity. Previous work has shown that this survey has strong test-retest reliability and validity in White and Black women (32,33). Analyses used physical activity measured at baseline.

Unhealthy Dietary Patterns—Dietary patterns were measured using the Food Frequency Questionnaire (34). The core food list included 103 items covering 90% of population nutrient intake of each nutrient. Participants reported their frequency of intake and portion size of each food. An unhealthy dietary pattern was operationalized by the combination of the following variables: servings of fruits and vegetables per day, grams of saturated fat per day, and grams of dietary fiber per day. A summary score was created by standardizing the scores based on sample distribution and averaging. Thus, high scores on the unhealthy dietary pattern variable indicated high grams of saturated fat, low servings of fruits and vegetables, and low grams of dietary fiber. The Food Frequency Questionnaire has been validated using four-day diet records in middle-aged women (35). Analyses used responses to the Food Frequency Questionnaire at baseline.

Alcohol and Substance Abuse/Dependence—Daily, weekly, and monthly servings of alcohol were assessed by the Food Frequency Questionnaire (34). The frequency of drinking in the present sample was low, with seven participants reporting three drinks per week, which was the highest frequency of recorded drinking. To identify problematic drinking, we assessed diagnosis of lifetime alcohol abuse and dependence with the Structured Clinical Interview for DSM Disorders (SCID; 36). The SCID is a standard semi-structured interview used in many

clinical and epidemiological studies to assess psychiatric disorders. It was conducted by a trained interviewer at baseline in SWAN. Participants who were diagnosed with lifetime alcohol abuse or dependence were combined into one group because of small numbers ($n = 35$). We also examined participants who were diagnosed with lifetime substance abuse or dependence ($n = 21$).

Depressive Symptoms—Depressive symptoms were assessed by the Center for Epidemiological Studies Depression scale (CES-D) (37). This is a 20-item scale measuring depressive symptoms with four-level responses indicating frequency of experiencing each symptom in the past week. Scores ranged from 0 to 60. The CES-D has well-established reliability (Cronbach's $\alpha = 0.85$) and has been shown to correlate well with other depressive symptom questionnaires and with interview assessments of severity of depression (38). Cronbach's α for the present sample was 0.89. Analyses used depressive symptoms measured at baseline.

Trait Anger—Participants completed the Trait Anger scale of the State-Trait Personality Inventory (39). The Spielberger Trait Anger scale contains 10 statements concerning the frequency with which the emotion of anger is experienced. Example items reflecting Trait Anger are, "I am quick-tempered" and "I feel infuriated when I do a job and get a poor evaluation." Each statement was rated on a four-point scale ranging from 1 (almost never) to 4 (almost always); high scores reflected high levels of anger. The Trait Anger scale has good internal consistency (0.81-0.92) and validity with other measures of anger and hostility (39). Trait Anger was assessed at visit 7, and Cronbach's $\alpha = 0.86$ for the present sample.

Trait Anxiety—Anxiety was measured by the Trait Anxiety scale of the State-Trait Personality Inventory (40). Participants were asked to respond to 10 items on the basis of how they generally feel. Example Trait Anxiety items are "I feel nervous and restless" and "I am a steady person." Items were scored on a four-point scale ranging from 1 (almost always) to 4 (almost never). High scores reflected high levels of anxiety. The STAI has high internal consistency (0.86 - 0.95) and good test-retest reliability (0.64 - 0.86) (40). Trait Anxiety was measured at visit 4, and Cronbach's $\alpha = 0.85$ in the present sample.

Cynicism—Cynicism was assessed using 13 true/false items derived from the Cook-Medley Hostility Scale (41,42), which measures cynical attitudes and hostile feelings and behaviors. Scores could range from 0 to 13; higher scores indicated greater cynicism. The Cook-Medley Hostility Scale had strong test-retest reliability over 3 years (0.88) in a sample of postmenopausal women (43) and was shown to predict visceral adipose tissue in postmenopausal women (44). Cynicism was measured at baseline and Cronbach's $\alpha = 0.91$ in the present sample.

Reproductive Hormones—Estradiol, testosterone, FSH, and serum concentrations of SHBG were obtained from a single morning fasting blood sample taken during the baseline SWAN visit and visit 8. The free estrogen index (FEI) was calculated: $100 \times E2$ (pg/mL) / $272.11 \times SHBG$ (nmol/L), and the free androgen index (FAI) was calculated: $100 \times T$ (ng/dL) / $SHBG$ (nmol/L) (45). Samples were taken on days 2-5 of a spontaneous menstrual cycle; if a timed sample could not be obtained because of variability in cycling, a random fasting sample was taken. Estradiol assays were conducted in duplicate (average was used for analyses), and FSH, SHBG, and testosterone assays in singulate. All assays were performed using an ACS-180 automated analyzer (Bayer Diagnostics Corporation, Tarrytown, New York) utilizing a double-antibody chemiluminescent immunoassay with a solid phase anti-IgG immunoglobulin conjugated to paramagnetic particles, anti-ligand antibody, and competitive ligand labeled with dimethylacridinium ester. Estradiol had a lower limit of detection of 1.0 pg/ml, testosterone

had a lower limit of detection of 2.19 ng/dL, FSH had a lower limit of detection of 1.05 mIU/mL, and SHBG had a lower limit of detection of 1.95 nM. Scores were log transformed to reduce skewness.

Covariates

Race/ethnicity was self-identified as white or African American during the baseline SWAN interview. Menopause status was identified as premenopause or early perimenopause at baseline. Adulthood SES was a measure of the highest grade completed by the participant, assessed at baseline.

Statistical Analyses

Chi-square analysis examined associations between race and abuse/neglect. Independent t-tests were used to test for differences on baseline anthropometric variables, covariates, negative emotions, and adulthood SES between participants who completed the CTQ and those who did not. Due to their associations with adiposity, covariates for all cross-sectional analyses were age at baseline, menopausal status at baseline, race, and adulthood SES. Covariates for longitudinal analyses also included time duration between anthropometric measurements.

Analysis of covariance (ANCOVA, 2 groups, yes/no any abuse or neglect) was used to examine whether abused/neglected women had significantly higher WC at baseline than non-abused/neglected women. Similar analyses were conducted for each subtype of abuse, as well as for the outcome of BMI at baseline. ANCOVAs tested whether a history of abuse/neglect was associated with changes in WC or BMI from baseline to visit 8.

BMI and WC were strongly correlated in the present sample ($r = .92, p < .001$); therefore, interactions were used to disentangle WC and BMI. Participants were stratified into 2 groups: those with a BMI < 30 (normal-weight and overweight individuals), and those with a BMI $\geq$ 30 (obese individuals). Linear regressions were used to examine whether the interaction between abuse and levels of BMI significantly predicted baseline WC and changes in WC.

Potential mediators of cross-sectional relationships between childhood abuse/neglect and adiposity included negative health behaviors, lifetime alcohol abuse/dependence, lifetime substance abuse/dependence, negative emotions, and reproductive hormones assessed at baseline or visits closest to baseline. Possible mediators of associations between abuse/neglect and changes in adiposity included negative health behaviors and negative emotions assessed at baseline or visits closest to baseline, lifetime alcohol abuse/dependence, lifetime substance abuse/dependence, and changes in reproductive hormones, computed as the difference between baseline and visit 8. The Sobel test (46) was used to quantify whether targeted mediators significantly attenuated relationships between childhood abuse/neglect and central adiposity and obesity. We did not correct for the number of statistical tests because our primary analyses were based on the study hypotheses.

Results

Participant Characteristics

Comparisons of baseline characteristics between the 311 participants that were included in the present study and the 132 non-participants showed no differences in race, WC, BMI, age, and adulthood SES. At baseline, the non-participants had significantly higher depressive symptoms, $t(441) = 2.96, p < .01$, higher cynicism, $t(429) = 2.46, p = .01$, and were more likely to be perimenopausal, $t(441) = -2.96, p < .01$, than participants who were included in the study. Table 1 shows descriptive characteristics of the study sample.

Thirty-six percent ($n = 112$) of the sample reported experiencing some form of childhood abuse/neglect. Table 2 shows the number of participants reporting each type of abuse/neglect, as well as a breakdown of types of abuse/neglect by race. Emotional abuse was reported most often and emotional neglect least often. Physical abuse was reported by approximately 17% of women and sexual abuse was reported by about 14% of women. Analyses showed that Blacks experienced significantly more physical abuse than did Whites ($\chi^2 = 15.49, p < .001$). There were no significant differences for a history of any childhood abuse/neglect or other subtypes of abuse/neglect between Whites and Blacks ($ps \geq .22$).

Abuse/Neglect and Anthropometric Indices at Baseline

Table 3 shows that women who reported any abuse/neglect in childhood had higher WC and BMI at baseline, adjusted for age at baseline, menopausal status at baseline, adulthood SES, and race. Additionally, a history of physical abuse or sexual abuse was associated with higher WC and BMI at baseline (Table 3). Interaction terms between abuse/neglect and baseline categorical BMI were not significant when predicting baseline WC ($ps \geq .10$), with the exception of a trend for the interaction between emotional neglect and baseline BMI ($\beta = -0.09, p = .07$). However, stratified analyses showed that emotional neglect was not significantly associated with baseline WC for normal-weight and overweight women ($F(1,192) = 2.31, p = .13$) or obese women ($F(1,102) = 1.39, p = .24$). Analyses using WC and BMI at visit 8 (concurrent with assessment of childhood abuse/neglect) showed similar results.

Abuse/Neglect and Changes in Anthropometric Indices over 8 Years

Results suggested that women with any childhood abuse/neglect and some subtypes of abuse/neglect did not have significantly greater increases in WC than non-abused women ($ps \geq .21$), although women reporting emotional abuse and emotional neglect tended to have greater increases in WC over 8 years ($F(1,300) = 3.26, p = .07$) and ($F(1,299) = 2.84, p = .09$), respectively. Analyses showed that women reporting any abuse/neglect or subtypes of abuse/neglect did not have significantly greater increases in BMI than non-abused women ($ps \geq .22$).

Interaction terms between any abuse/neglect and baseline BMI were significant in analyses of changes in WC, adjusted for age at baseline, menopausal status at baseline, race, adulthood SES, and time duration between WC measurements (Table 4). Specifically, women who were normal-weight or overweight at baseline and reported any childhood abuse/neglect had significantly greater increases in WC over time than non-abused women. The association was non-significant for obese women.

Interaction terms between subtypes of abuse/neglect and baseline BMI were also significantly related to changes in WC, with the exclusion of emotional neglect. Normal-weight and overweight women at baseline who reported childhood emotional abuse, physical abuse, sexual abuse, or physical neglect had greater increases in WC than non-abused women. There were also significant relationships in the BMI ≥ 30 group: obese women who reported physical abuse had smaller increases in WC than non-abused women and those reporting sexual abuse had a decrease in WC compared to the gain seen in non-abused women (see Table 4).

Mediators between Abuse and Anthropometric Indices

Sobel tests of mediation showed that negative health behaviors did not significantly mediate any relationships between abuse/neglect and baseline WC or baseline BMI ($ps \geq .20$). Diagnosis of lifetime alcohol abuse/dependence showed a non-significant trend as a mediator between histories of any abuse/neglect and baseline WC ($z = 1.76, p < .08$) and physical abuse and baseline WC ($z = 1.66, p < .10$). Relationships between abuse/neglect and baseline BMI were not significantly mediated by lifetime alcohol abuse/dependence ($ps \geq .10$). Lifetime

substance abuse/dependence was not a significant mediator between childhood abuse and baseline WC or BMI ($ps \geq .23$).

Trait Anger was the only negative emotion that significantly attenuated relationships, specifically between any abuse/neglect and baseline WC ($z = 2.09, p = .04$), physical abuse and baseline WC ($z = 2.11, p = .03$), and sexual abuse and baseline WC ($z = 1.95, p = .051$). Additionally, Trait Anger significantly mediated the relationships between any abuse/neglect and baseline BMI ($z = 2.13, p = .03$), physical abuse and baseline BMI ($z = 2.14, p = .03$), and sexual abuse and baseline BMI ($z = 1.95, p = .052$). Tests of mediation were confirmed with analyses using WC and BMI measured at visit 8. All other negative emotion mediators were not significant ($ps \geq .30$).

Mediation analyses using Sobel tests showed that lower levels of baseline SHBG significantly mediated between any abuse/neglect and baseline WC ($z = 2.33, p = .02$), physical abuse and baseline WC ($z = 1.99, p < .05$), and there was a trend for mediation between sexual abuse and baseline WC ($z = 1.90, p < .06$). Additionally, lower levels of SHBG significantly attenuated the relationship between any abuse/neglect and baseline BMI ($z = 2.37, p = .02$), physical abuse and baseline BMI ($z = 2.01, p = .04$), and lower levels of SHBG tended to mediate between sexual abuse and baseline BMI ($z = 1.92, p = .06$). It is noteworthy that some reproductive hormones, specifically FEI and FAI, were significantly correlated to WC ($r = .13, p = .03$; $r = .23, p < .01$) and BMI ($r = .15, p = .01$; $r = .25, p < .01$), respectively. However, these reproductive hormones did not significantly attenuate relationships between abuse/neglect and baseline WC or BMI ($ps \geq .16$).

Sobel tests of mediation showed that negative health behaviors, diagnosis of lifetime alcohol or substance abuse/dependence, negative emotions, or reproductive hormones did not significantly mediate relationships between childhood abuse/neglect and changes in WC for normal-weight and overweight women ($ps \geq .10$).

Discussion

The prevalence of abuse/neglect in our sample of women is similar to other reports of abuse/neglect using the CTQ. Walker and colleagues (29) examined 1225 women members of a health maintenance organization and found that 43% reported some history of abuse/neglect (versus 36% in our sample), with the following prevalence rates for subtypes: emotional abuse = 24% (versus 20%), physical abuse = 14% (versus 17%), sexual abuse = 18% (versus 14%), emotional neglect = 21% (versus 6%), and physical neglect = 12% (versus 15%). A study assessing over 9000 women from a health maintenance organization reported a slightly higher pattern of prevalence using items from validated measures other than the CTQ, 27% endorsed physical abuse, 25% endorsed sexual abuse, and 13% endorsed emotional abuse (47).

The present study tested for an association between reports of childhood abuse/neglect and adulthood central adiposity and obesity in Black and White women. It found that women who reported any childhood abuse/neglect had higher central adiposity and obesity in adulthood than women who reported no abuse/neglect. These findings are consistent with the literature connecting childhood abuse to central adiposity and obesity (16,48), but improved upon the empirical evidence by using a validated and reliable measure of childhood abuse/neglect.

Our study also showed that the specific subtypes of abuse that related to adiposity were physical and sexual abuse, as opposed to neglect or emotional abuse. Physical and sexual abuse may be more severe childhood stressors than other forms of abuse or neglect. In addition, questions assessing physical and sexual abuse in the CTQ may require less subjective evaluation than questions pertaining to emotional abuse and neglect ("I was punished with a belt, a board, a cord, or some other hard object" versus "I felt that someone in my family hated me"). There

is some research indicating that recall for childhood experience is poorest for subjective perceptions and best for concrete events and behaviors (49).

Childhood abuse/neglect was not associated with changes in central adiposity or obesity across the 8 years of follow-up in the full sample. However, among women with baseline BMI < 30, a history of any abuse/neglect was related to greater increases in WC over eight years. This is the first study to report on the relationship between childhood abuse/neglect and changes in central adiposity. Normal-weight and overweight women who experienced emotional abuse, physical abuse, sexual abuse, or physical neglect had greater increases in central adiposity compared to non-abused women. The null effect for emotional neglect may be related to low power with only 14 women reporting neglect in this BMI category. The findings suggest that most forms of victimization early in life are related to increases in central adiposity over time, particularly for normal-weight and overweight women.

The results for obese women were unexpected, in that obese women reporting physical or sexual abuse had smaller increases or decreases in central adiposity. Although these findings are not readily understood, research by Wiederman et al. (50) offers one possible explanation. They found that sexually abused obese women displayed less weight fluctuation relative to non-abused obese women, whereas sexually abused normal-weight women displayed greater weight fluctuation compared to their non-abused normal-weight peers. Perhaps central adiposity is also less variable in abused obese women.

This is the first study to test whether negative emotions mediated the relationship between childhood abuse/neglect and adiposity. Trait Anger was a significant mediator in cross-sectional relationships between childhood abuse/neglect and central adiposity and obesity. Perspectives from developmental psychopathology suggest that abused/neglected children demonstrate problems with emotion regulation, which is the way affect is redirected, controlled, modulated, and modified to enable the individual to function adaptively in emotionally arousing situations (definition in 51). Maltreated children experience more negative emotions, specifically anger, fear, and aggression, when with peers and adults. Furthermore, abused/neglected children are hypervigilant and sensitized to witnessing aggressive stimuli (see review in 48). Previous literature has suggested that anger is a particularly detrimental emotion that influences the development of central adiposity, more so than depression, anxiety, and cynicism both in adults (52) and in adolescents (20).

This study was also the first to test whether reproductive hormones (testosterone, estradiol, FSH, FAL, FOL, and SHBG) mediated between childhood abuse/neglect and central adiposity and obesity. Only SHBG significantly attenuated the cross-sectional relationships between childhood abuse/neglect and central adiposity and obesity. SHBG is produced by the liver cells and is a carrier protein, binding to testosterone and estradiol and inhibiting their function. Hence, lower levels of SHBG would be associated with higher levels of unbound, bioavailable testosterone and estrogen. Previous studies have suggested that lower levels of SHBG in middle-aged premenopausal women were associated with greater central adiposity and obesity (53,54). It is noteworthy that our tests of mediation were not driven solely by associations between SHBG and adiposity; exploratory analyses showed that any abuse/neglect predicted SHBG, even after controlling for central adiposity ($\beta = -.12, p = .03$) or obesity ($\beta = -.11, p = .04$). Our findings are the first to show that childhood abuse and neglect are related to levels of SHBG in mid-life.

Several studies show that childhood abuse/neglect is related to alcohol abuse in adulthood, particularly for women, as noted in a review by Widom and Hiller-Sturmhöfel (55). The authors suggest that abused children and adolescents may rely on alcohol to help cope with negative emotions or hyperarousal. Another possibility is that the childhood abuse may lead to antisocial

behavior, one form being alcohol abuse or dependence (55). Moderate to high intake of alcohol has been shown to be related to high central adiposity later in life (56). However, in our study, a history of alcohol abuse/dependence only tended to mediate the association between childhood abuse and central adiposity.

Although the data indicates non-significant mediating effects for negative health behaviors, we cannot disqualify the potential importance of negative health behaviors. Low physical activity and an unhealthy dietary pattern were significantly correlated to central adiposity and obesity, but these negative health behaviors were not related to a history of abuse/neglect. In addition, the low frequency of current smokers in this sample (16.1%) may have precluded significant associations.

It is possible that a physiological mechanism, other than reproductive hormones, may be linking abuse/neglect history to body fat distribution. Childhood abuse/neglect may affect body fat distribution by directly activating the hypothalamic-pituitary-adrenal (HPA) axis, which releases the hormone cortisol. Visceral adipose tissue is particularly sensitive to circulating cortisol due to increased blood flow and glucocorticoid receptors (57), and cortisol promotes differentiation of preadipocytes into adipocyte cells and stimulates lipogenesis (58). Elevated cortisol secretion has been documented in samples of sexually and physically abused children and adolescents (59-61). Other research has suggested that autoimmune processes may also be important; Dube and colleagues (62) recently reported that cumulative childhood traumatic stress (including emotional, physical, and sexual abuse) was associated with hospitalization for autoimmune diseases. We did not have comprehensive neuroendocrine or immunity measures in the present study so we cannot evaluate these mechanisms.

There are several limitations to the current study. Although a history of childhood abuse/neglect was associated with central adiposity and obesity in midlife, the causal nature of these associations cannot be established. The extent to which our findings are generalizable to younger or older women or to men cannot be determined. Additionally, a retrospective measure of childhood abuse and neglect has limitations because recall of temporally distant and emotionally painful events has the potential for distortion, possibly because of repression, denial, or current mood at time of recall (63). However, studies that use legal records to classify children as abused may misclassify cases that never reach the criminal justice system as "not abused," thus biasing results toward the null (64). Children identified by the legal system as being abused not only receive intervention, but in most situations the abuse usually stops, suggesting that identified children may not be representative of all abused children (65). Parental or caretaker reports would also be unsuitable alternatives, given the social and legal implications of self-identification as a child abuser.

Given the challenges with retrospective and prospective reports of childhood abuse/neglect, a strength of the present study is its use of a well-validated and reliable assessment of multiple forms of abuse and neglect. The Childhood Trauma Questionnaire has been evaluated in psychiatric and normal populations, corroborated with clinician interviews, and standardized for appropriate cut-off scores to minimize false-positives or false-negatives. Results from this questionnaire indicated that 36% of the women in our sample were abused or neglected, which may appear to be high, but rates of maltreatment within each subtype of abuse/neglect generally fall into the ranges recently reviewed by Gilbert et al. (1). Another strength of the present study is its longitudinal design and diverse sample. The longitudinal design aids researchers in understanding the progression of health outcomes and their risk factors. Previous research between childhood abuse/neglect and obesity has not explored whether race was associated with outcomes. Our sample was 34% Black, which allowed us to investigate whether race influenced outcomes, and improved the generalizability of our findings.

In conclusion, results from the present study showed that childhood abuse and neglect were associated with adulthood adiposity. This study also clarified possible mechanisms between early-life victimization and adulthood health. Children who are abused may be sensitized to experiencing anger, particularly in interpersonal interactions with heightened perceived threat, and over time these frequent expressions of anger may have a toxic effect on adiposity. Additionally, abuse and neglect were associated with dysregulated physiology, specifically lower SHBG, and this carrier protein was linked to increased adiposity.

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Glossary

SWAN	Study of Women's Health Across the Nation
BMI	body mass index
WC	waist circumference
ANCOVA	Analysis of Covariance
SHBG	sex hormone-binding globulin
FSH	follicle stimulating hormone
FEI	free estrogen index
FAI	free androgen index
CTQ	Childhood Trauma Questionnaire
CESD	Center for Epidemiological Studies Depression
SES	socioeconomic status
HPA	hypothalamic-pituitary-adrenal axis

Table 1
Characteristics of Participants (n = 311)

Characteristic	Baseline
Age – mean (SD)	45.7 (2.5)
% Black (n)	34.1 (106)
Adulthood SES (highest grade completed by participant) – mean (SD)	15.1 (2.2)
Menopause Status - % Premenopausal (n)	56.3 (175)
WC (cm) - mean (SD)	87.6 (15.1)
BMI - mean (SD)	28.6 (6.3)

Table 2
Rates of Reported Abuse/Neglect in the Full Sample (N = 311)

Type of Abuse/Neglect	N (%) of Total Sample	N (%) of Blacks	N (%) of Whites
Any childhood abuse/neglect	112 (36.0%)	43 (40.6%)	69 (33.7%)
Emotional abuse	61 (19.6%)	18 (17.0%)	43 (21.0%)
Physical abuse ^a	52 (16.7%)	30 (28.3%)	22 (10.7%)
Sexual abuse	44 (14.1%)	18 (17.0%)	26 (12.7%)
Emotional neglect	20 (6.4%)	5 (4.7%)	15 (7.3%)
Physical neglect	43 (14.8%)	16 (15.1%)	27 (13.2%)

^a Blacks reported more physical abuse than Whites ($\chi^2 = 15.49$, $p < .001$).

Table 3
Estimated Marginal Means (Standard Errors) and F Values from ANCOVAs Examining Abuse/Neglect Status and Baseline WC

			Baseline WC		Baseline BMI	
Type of Abuse/Neglect	N	Mean (SE)	F-value, p-value	Mean (SE)	F-value, p-value	
Any Abuse/Neglect:	No	86.32 (1.04)		28.07 (0.43)		
	Yes	89.88 (1.39)	4.17, = .04	29.64 (0.58)	4.79, = .03	
Emotional Abuse:	No	87.25 (0.93)		28.45 (0.39)		
	Yes	89.07 (1.90)	0.74, = .39	29.39 (0.79)	1.16, = .28	
Physical Abuse:	No	86.83 (0.92)		28.28 (0.38)		
	Yes	91.42 (2.08)	3.99, < .05	30.38 (0.86)	4.90, = .03	
Sexual Abuse:	No	86.95 (0.90)		28.27 (0.37)		
	Yes	91.95 (2.21)	4.36, = .04	30.96 (0.91)	7.44, < .01	
Emotional Neglect:	No	87.65 (0.87)		28.69 (0.36)		
	Yes	87.17 (3.30)	0.02, = .89	27.84 (1.36)	0.37, = .55	
Physical Neglect:	No	87.68 (0.90)		28.68 (0.37)		
	Yes	87.19 (2.24)	0.04, = .84	28.37 (0.93)	0.10, = .76	

Note: BMI = body mass index; WC = waist circumference. Analyses adjusted for baseline age, baseline menopausal status, race, and adulthood socioeconomic status.

Table 4
Interactions between Abuse/Neglect and Baseline BMI Predicting Changes in WC; ANCOVA Analyses Separated by BMI

Δ WC						
		Abuse * Baseline BMI Interaction	Baseline BMI < 30 (N = 202)	Baseline BMI $\geq$ 30 (N = 109)		
Type of Abuse/Neglect		Beta, p-value	Mean (SE)	F-value, p-value	Mean (SE), N	F-value, p-value
Any Abuse/Neglect:	No	-0.32, < .01	4.39 (.61), n = 135	13.98, < .01	5.18 (1.16), n = 61	2.57, = .11
	Yes		8.41 (.88), n = 64		2.33 (1.32), n = 47	
Emotional Abuse:	No	-0.26, < .01	4.73 (.55), n = 161	15.31, < .01	4.55 (.97), n = 86	1.93, = .17
	Yes		9.73 (1.15), n = 38		1.55 (1.93), n = 22	
Physical Abuse:	No	-0.28, < .01	5.28 (.56), n = 175	4.30, = .04	5.09 (1.01), n = 80	4.37, = .04
	Yes		8.61 (1.50), n = 24		.65 (1.79), n = 28	
Sexual Abuse:	No	-0.39, < .01	5.10 (.54), n = 174	9.42, < .01	5.25 (.92), n = 88	10.43, < .01
	Yes		9.97 (1.48), n = 24		-1.85 (1.97), n = 20	
Emotional Neglect:	No	-0.04, = .54	5.40 (.53), n = 184	3.45, = .07	3.84 (.89), n = 102	0.23, = .63
	Yes		9.16 (1.95), n = 14		5.69 (3.74), n = 6	
Physical Neglect:	No	-0.17, = .02	5.22 (.55), n = 170	4.83, = .03	4.32 (.93), n = 94	1.29, = .26
	Yes		8.41 (1.34), n = 29		1.38 (2.41), n = 14	

Note: BMI = body mass index; WC = waist circumference. Analyses adjusted for baseline age, baseline menopausal status, race, adulthood socioeconomic status, and time duration between WC measurements.