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A Prospective Examination of the Mechanisms Linking Childhood Physical Abuse to Body Mass Index in Adulthood

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Abstract

Previous research has reported associations between childhood physical abuse and Body Mass Index (BMI) in adulthood. This paper examined the role of four potential mediators (anxiety, depression, posttraumatic stress, and coping) hypothesized to explain this relationship. Using data from a prospective cohort design, court-substantiated cases of childhood physical abuse ($N = 78$) and non-maltreated comparisons ($N = 349$) were followed-up and assessed in adulthood at three time points (1989–1995, 2000–2002, and 2003–2005) when participants were ages 29.2, 39.5, and 41.2, respectively. At age 41, average BMI of the current sample was 29.97, falling between overweight and obese categories. Mediation analyses were conducted, controlling for age, sex, race, smoking, and self-reported weight. Childhood physical abuse was positively associated with subsequent generalized anxiety, major depression and posttraumatic stress disorder symptoms at age 29.2 and higher levels of depression and posttraumatic stress predicted higher BMI at age 41.2. In contrast, higher levels of anxiety predicted lower BMI. Coping did not mediate between physical abuse and BMI. Anxiety symptoms mediated the relationship between physical abuse and BMI for women, but not men. These findings illustrate the complexity of studying the consequences of physical abuse, particularly the relationship between psychiatric symptoms and adult health outcomes.

Childhood physical abuse and adult obesity are serious public health problems that affect millions of people in the United States and abroad (Ogden, Yanovski, Carroll, & Flegal, 2007; United States Department of Health and Human Services, 2007). Several studies have reported that physically abused children are at increased risk for higher weight and obesity in adulthood (Bentley & Widom, 2009; Hussey, Chang, & Kotch, 2006; Jia, Li, Lesserman, Hu, & Drossman, 2004; Johnson, Cohen, Kasen, & Brook, 2002; Rohde et al., 2008; Thomas, Hyppönen, & Power, 2008; Williamson, Thompson, Anda, Dietz, & Felitti, 2002). However, most of this work relies on cross-sectional studies with retrospective self-reports of childhood experiences (Hussey et al., 2006; Jia et al., 2004; Rohde et al., 2008; Thomas et al., 2008; Williamson et al., 2002). One prospective study (Bentley & Widom, 2009) followed up a group of children who had been physically abused and found that physical abuse predicted higher Body Mass Index (BMI) almost 30 years later in middle adulthood. The current paper extends this earlier work by Bentley and Widom (2009) by examining potential mechanisms that may explain the relationship between childhood physical abuse and higher BMI in middle adulthood.

Studying BMI in adulthood is important for a number of reasons. Elevated BMI in middle adulthood poses a risk for diseases with high rates of morbidity and mortality (Kochanek, Xu, Murphy, Minino, & Kung, 2011), including hypertension, diabetes, and cardiac disease (Manson et al., 1990; Power & Thomas, 2011; Wannamethee & Shaper, 1999; Yan et al., 2006). Health related concerns may become more prominent in middle adulthood (Hooker & Kaus, 1994) and this is likely an important time for physician intervention. Obesity interventions that tailor content to the needs of the patient have demonstrated efficacy (Tufano & Karras, 2005). In addition, developmental (Greenfield & Marks, 2009; Repetti, Taylor, & Seeman, 2002) and biological theories (Fagundes & Way, 2014) suggest that the impact of childhood stressors on health may not be manifest until adulthood.

A number of potential mechanisms, emerging in late adolescence and early adulthood (Johnson, Cohen, Kasen, & Brook, 2006; Repetti et al., 2002), have been proposed to explain the link between childhood physical abuse and adult health outcomes, including higher BMI. One explanation suggests that symptoms of mental health problems associated with the consequences of childhood physical abuse (e.g., anxiety, depression, helplessness, re-experiencing of traumatic experiences, and appetite changes) may disrupt a person's ability to engage in healthy eating and self-care, leading to obesity (Norman et al., 2012; Rohde et al., 2008; Springer, Sheridan, Kuo, & Carnes, 2007). A number of studies have shown that physically abused children are likely to develop depressive symptomatology (Norman et al., 2012; Rohde et al., 2008; Springer et al., 2007; Widom, DuMont, & Czaja, 2007) and depression has been associated with an increased risk for obesity, particularly among women (Anderson, Cohen, Naumova, & Must, 2006; Blaine, 2008; Dave, Tennant, & Colman, 2011). The relation between depression and BMI may be also bi-directional and weight gain may exacerbate symptoms of depression (Blaine, 2008; Markowitz, Friedman, & Arent, 2008). Researchers have called for prospective longitudinal studies to help disentangle the influences of depression on obesity (Lau et al., 2007). Physical abuse has been linked to later anxiety symptoms (MacMillan et al., 2001; Springer et al., 2007) and other studies have reported positive relationships between anxiety and adult BMI or obesity (Anderson et al., 2006; Hach, Ruhl, Klose, Klotsche, Kirch, & Jacobi, 2007; Scott, McGee, Wells, & Oakley Browne, 2008; Simon et al., 2006).

Another possibility is that, in response to the stresses of their childhood, physically abused children cope by engaging in risk behaviors, such as overeating, smoking, risky sexual behaviors, and excessive alcohol consumption, rather than more adaptive ways of coping (Felitti et al., 1998). Research has linked physical abuse to ineffective coping strategies that may contribute to poor health (Gipple, Lee, & Puig, 2006; Zeidner & Saklofske, 1996). For example, over-reliance on emotion-focused and avoidance coping (Gipple et al., 2006; Leitenberg, Gibson, & Novy, 2004) has been linked to poor health outcomes such as chronic pain and immune dysfunction (Newth & DeLongis, 2004; Temoshok, Wald, Synowski, & Garzino-Demo, 2008). Adults with histories of childhood abuse displayed greater emotional reactivity to daily-life stressors than adults without such histories (Glaser, van Os, Portegijs, & Myin-Germeys, 2006). Retrospective report studies have also found that an inability to apply adaptive coping strategies, or an inability to manage stress efficiently, partially explained the relations between physical abuse and health difficulties, especially for women (Hager & Runtz, 2012). In a study that used harsh parenting in childhood as a proxy for

physical abuse, Greenfield and Marks (2009) found that coping with stressors by emotional eating linked childhood violence to adult obesity in both women and men.

Higher BMI may have different associations with health for men and women. Compared to men, women may be able to tolerate higher BMI without experiencing negative health effects because the weight is distributed differently across women's and men's bodies (Seidell & Flegal, 1997). Pathways and risk factors for higher BMI may differ by sex as well (Gonzalez, Nazmi, & Victora, 2009). One review concluded that girls raised in disadvantaged environments are at greater risk for later obesity than boys (Gonzalez et al., 2009). In one longitudinal study, childhood depression and anxiety were associated with higher BMI among girls but not boys (Anderson et al., 2006), and these authors suggested that there may be sex differences in the association of BMI with depression and anxiety. This body of work suggests that there may be sex differences in the pathways that link childhood physical abuse to adult BMI.

In sum, although there has been considerable speculation about potential mechanisms that may explain the link between childhood physical abuse and adult obesity, there has been scant empirical research testing these hypothesized mediators. Furthermore, existing studies are cross-sectional in nature and, thus, the direction of potential causality cannot be determined. The goal of the current work was to examine the role of mental health problems and coping as mechanisms that might help explain the links between childhood physical abuse and higher BMI in adulthood.

The Current Study

The current research used data from a prospective cohort design study in which children with court substantiated cases of physical abuse and comparison group were followed up and assessed in adulthood at three time points. The information used to examine potential mechanisms linking childhood physical abuse to adult BMI was collected in a temporally correct sequence. The assessment of physical abuse was based on court cases in childhood, potential mediating factors were assessed at two time points in adulthood, and BMI was assessed at a later point in time. Thus, the prospective design and use of court substantiated cases overcame a number of limitations (i.e., cross-sectional studies that rely on retrospective reports of childhood physical abuse) of prior research that have reported associations between childhood adversities and physical health outcomes, including obesity (Felitti & Anda, 2010; Felitti et al., 1998; Williamson et al., 2002).

The present study tested five hypotheses. First, individuals with documented histories of childhood physical abuse were predicted to have higher BMI scores in middle adulthood than a comparison group without such histories. Second, individuals with histories of physical abuse were hypothesized to report higher symptoms of depression, anxiety, and posttraumatic stress disorder, as well as ineffective coping strategies in middle adulthood than the comparison group. Third, symptoms of depression, anxiety, and posttraumatic stress, and ineffective coping at ages 29.2 and 39.5 were hypothesized to predict higher BMI at age 41.2. Fourth, symptoms of depression, anxiety, and posttraumatic stress, and coping strategies were predicted to mediate the relationship between physical abuse in childhood

and higher BMI scores in adulthood. Fifth, sex differences were predicted in the mediating pathways between childhood physical abuse, the mediators, and BMI, such that the role of the mediators would be stronger for women than men.

Method

Design and Participants

Data were collected as part of a large prospective cohort design study in which abused and/or neglected children were matched with non-abused and non-neglected children and followed into adulthood. The original sample was composed of all substantiated cases of childhood physical and sexual abuse and neglect processed from 1967 to 1971 in the county juvenile (family) or adult criminal courts of a Midwestern metropolitan area. Cases of abuse and neglect were restricted to children 11 years of age or less at the time of the incident and, therefore, represent childhood maltreatment. Eleven percent of the maltreated participants experienced more than one type of maltreatment. The current study focused on individuals with documented histories of childhood physical abuse and controls. A critical element of the original design involved the selection of a control group, matched with the maltreated sample on the basis of age, sex, race/ethnicity, and approximate family social class during the time period under study (Widom, 1989a). This matching was important because it is theoretically plausible that any relationship between child abuse and neglect and subsequent outcomes is confounded with or explained by social class differences (MacMillan, et al., 2001; Widom, 1989b). Any potential control group child ($n = 11$) with an official record of abuse or neglect was eliminated, regardless of whether the record was before or after the period of the study.

This paper uses information collected from individuals with histories of childhood physical abuse and a non-maltreated comparison group over three time points 1989-1995 (average age = 29.2, $SD = 3.8$); 2000-2002 (average age = 39.5, $SD = 3.5$); and 2003-2005 (average age = 41.2, $SD = 3.6$). Analyses in the current paper included all comparison group participants because restricting the analyses to matched pairs would have significantly reduced the sample size, power to assess significant differences, and the generalizability of the findings to a broader group of children who did not experience maltreatment. Because of race and ethnic differences in health status and BMI (Braveman, Cubbin, Egerter, Williams, & Pamuk, 2010) and because the sample was composed primarily of non-Hispanic Whites and Blacks, we excluded participants of other ethnic backgrounds (4%). The current sample is composed of 18% ($N = 78$) of the participants who took part in the 2003-2005 interviews and had documented histories of childhood physical abuse. The physical abuse and comparison groups did not differ in terms of age or sex (50.4% women), whereas there were more Whites (79.3%) among the physically abused than among the comparison participants (63.7%). However, among the comparison group, those matched to the physically abused group did not differ significantly from the remainder of the comparison group on demographic characteristics (age, race, and sex).

Procedures

At each assessment wave the following was standard protocol. Interviewers and participants were blind to the purpose of the study and to the inclusion of an abuse/neglect group. Participants were also told that they had been selected as part of a large group of individuals who grew up in that area during the late 1960s and early 1970s. They were interviewed in-person in their homes or, if preferred, another appropriate place. Institutional Review Board approval was obtained for each wave, and participants provided written or verbal (for those with limited reading ability) consent.

Measures

Childhood physical abuse was assessed through review of official records processed during the years 1967 to 1971. Physical abuse cases included injuries such as bruises, welts, burns, abrasions, lacerations, wounds, cuts, bone and skull fractures, and other evidence of physical injury.

Potential Mediators

Depression, Anxiety, and Posttraumatic Stress Disorder (PTSD)—The NIMH Diagnostic Interview Schedule – III- Revised (DIS-III-R; Robins, Helzer, Cottler, & Goldring, 1989) was used to assess the number of lifetime symptoms of Major Depressive Disorder, Generalized Anxiety Disorder, and PTSD according to DSM-III-R criteria (American Psychiatric Association, 1987) at mean age 29.2. The DIS-III-R is a highly structured interview schedule designed for use by lay interviewers. Field interviewers received a week of study-specific training and successfully completed practice interviews before beginning the study interviews. Field interviewer supervisors recontacted a random 10% of the respondents for quality control. Frequent contacts between field interviewers and supervisors were held to prevent interview drift, to monitor quality, and to provide continuous feedback. Adequate reliability for the DIS-III-R has been reported (Robins, Helzer, Croughan, & Ratcliff, 1981), in addition to acceptable inter-rater reliability (Rogers, 2001; Nezu, Ronana, Meadowas, & McLure, 2000). The criteria and symptoms for diagnosis of PTSD, Generalized Anxiety Disorder, and Major Depressive Disorder have remained largely the same from DSM-III-R through DSM-5 (APA 1987-2014).

Coping—Coping was assessed at two developmental time points in young and middle adulthood, which allowed the testing of both proximal and distal relations to the BMI assessment. During the first interview when the participants were mean age 29.2 (1989-1995), coping was assessed using an 11-item coping inventory adapted from the work of Stone and Neale (1984). Intended as an indicator of a person's coping strategy repertoire, this measure was designed to identify a person's general use of broad approaches to coping, regardless of the number or nature of problems faced. A smaller repertoire of coping strategies has been related to internalizing symptoms (Tolan, Gorman-Smith, Henry, Chung, & Hunt, 2002) and flexibility of a person's coping strategies in different contexts has been found to be a marker for better adjustment (Lang, Brown, Hodges, & Chaplin, 2012; Margolin et al., 2009; Pincus & Friedman, 2004). An overall coping score was calculated as

the mean of at least eight responses, and higher scores indicate greater use of varied types of potential coping responses ($M = 3.17$, $SD = .36$). Cronbach's alpha for this measure was .60.

The second coping assessment during the 2000-2002 interviews when participants were mean age 39.5 was adapted from the Coping Responses Inventory (CRI; Moos, 1993), a self-report scale designed to measure the approaches to coping with stressful life events. The CRI draws on the more traditional concept of coping (Folkman & Lazarus, 1980), where specific coping strategies are categorized as adaptive or maladaptive. Participants responded to 24-items that asked how often they engaged in various coping strategies, conceptualized as Problem-focused ($M = 21.42$ $SD = 4.71$), Emotion-focused ($M = 17.05$ $SD = 4.85$), or Cognitive-focused coping ($M = 18.64$ $SD = 3.47$). Reliability (Cronbach's alpha) for Problem-focused and Emotion-focused coping was .70 and .67, respectively. Cognitive-focused coping was lower ($\alpha = .32$) and was dropped from the analyses.

Outcome measure

Body Mass Index (BMI) was assessed during a medical status examination conducted between 2003 – 2005 (mean age = 41.2) using standardized equipment and procedures and performed by a licensed registered nurse (RN) in the participant's home or other quiet location of the person's choice (see Bentley & Widom, 2009). For height, participants were asked to remove their shoes and stand with their head, back, and heels against the wall. A cardboard measuring 8.5"X 11" was placed on the top of head so that it was parallel to the floor. A marker was placed at the underside of the cardboard and the participant was asked to step away from the wall. Using a standard measuring tape, height was measured in inches. Weight was measured to the nearest 0.2 lb/0.1 kg using a digital scale (Health O Meter digital battery scale, model no. 842, Sunbeam Products, Inc., Purvis, MS). BMI was calculated as kilograms/square of the height in meters. If participants refused the height and/or weight measurement, this information was obtained through self-report ($n = 73$). Individuals with histories of childhood physical abuse were not more likely to choose to self-report weight than controls ($X^2(1) = 2.02$, $p = .16$).

The average BMI in the sample was 29.97 ($SD = 7.80$, range: 14.78 – 71.15), just below the threshold of 30 for the obese category, according to standard classifications from the National Heart, Lung, and Blood Institute (2014). The BMI scores for the sample were highly positively skewed ($z_{skew} = 12$). Using national standards, 1.8% of the sample was categorized as underweight (BMI < 18.5), 24.1% normal weight (BMI: 18.5-24.9), 32.2% overweight (BMI: 25-29.9) and 42% obese (BMI > 30.0). Participants who self-reported weight were on average heavier ($M_{BMI} = 32.92$) than those who were measured ($M_{BMI} = 29.39$), $t(72) = 2.32$, $p = .02$.

In these analyses, BMI was treated as a continuous outcome measure, rather than a categorical measure. The original study (Bentley & Widom, 2009) on which this paper is based showed that childhood physical abuse did not predict membership in different weight classes among this sample of high BMI individuals. Considering BMI as a continuous measure avoids issues related to measurement error for individuals whose measurement are on the cusp of weight class cutoffs, and allows for a more sensitive examination of small to large differences between individuals even within defined categories (Jolliffe, 2004). This is

particularly relevant in this sample given the high prevalence of individuals within the overweight and obese categories (over 70%). In this sample, individuals with histories of childhood physical abuse may be heavier than those in the comparison group but may not be classified in a different category. Thus, the risk of higher BMI for poorer health outcomes among obese individuals may be missed with BMI categorization (Papalia et al., 2010). Furthermore, categorization contributes to loss of power in the analyses and increases type II error (Jolliffe, 2004; Lovasi et al., 2012).

Control Variables

Control variables were chosen based on their associations with BMI in prior literature (Lau et al., 2007). Participant age, sex, race, smoking, and self-reported weight were controlled in all analyses. Sex was first treated as a control variable, but was also used as a moderator in the mediation models. Smoking was defined as self-reported total pack years, i.e., the number of cigarettes smoked per day divided by 20 cigarettes per pack, multiplied by the number of years of smoking (Widom, Czaja, Bentley, & Johnson, 2012). Whether the person self-reported their weight was used to control for the effects of self-reported versus measured weight.

Analysis

Preliminary analyses were conducted to determine bivariate correlations. Mediation was assessed with PROCESS software (Hayes, 2012) for SPSS Version 20. This procedure departs from the traditional multi-stepped and inferential methods for detecting indirect effects (i.e., product of coefficient approach of the Sobel test) and allows for a direct quantification of indirect effects. PROCESS uses bootstrapping, an alternative method to testing mediation that does not assume normality of the sampling distribution and yields greater statistical power (Hayes, 2009). This approach is particularly relevant for highly skewed outcome variables, such as BMI in the current study. Each potential mediator (depression, anxiety, and PTSD symptoms and coping at ages 29.2 and 39.5) was examined separately in mediation analyses through PROCESS software on SPSS. All analyses controlled for race, age, sex, smoking and whether participants self-reported weight. Considering the comorbidity of psychiatric symptoms and the potential for complex relations to outcomes, multiple mediator models were also examined in two models: one in which all the mental health problems were considered together and the other in which the coping measures were considered together. Finally, sex was used as a moderating variable within the mediation models, permitting a test of conditional direct and indirect effects.

The PROCESS procedure assesses multiple effects in the mediation model simultaneously, which include (1) the effect of childhood physical abuse (independent variable), on the potential mediating variables, and (2) the effects of the mediating variables on BMI (dependent variable) in adulthood. Indirect, direct and total effects are also calculated. The indirect effect is the relation between childhood physical abuse and BMI in adulthood that can be accounted for by the mediator and its significance indicates the presence of mediation. In the PROCESS method, utilizing statistical bootstrapping, the significance of the indirect effect is assessed based on the confidence interval, where confidence intervals that do not contain zero are statistically significant. The direct effect describes the relation

between childhood physical abuse and BMI after the effect of the mediator has been taken into account or controlled. The total effect reflects the overall effect of physical abuse on BMI that accounts for the mediator path and the direct effect, that is, any other effect not accounted for by the mediator.

Results

Descriptive Information

Table 1 presents descriptive statistics for all variables in the analyses. Table 2 presents bivariate correlations among childhood physical abuse, each of the potential mediators, controls (age, race, sex, smoking, and weight report), and adult BMI. Childhood physical abuse was significantly related to BMI in adulthood as was PTSD. In contrast, Generalized Anxiety Disorder symptoms were negatively correlated with BMI.

Mediation Models

Table 3 presents the results of the separate mediation analyses for each potential mediator of the relation between physical abuse and BMI. The effect of childhood physical abuse (the independent variable) on each potential mediator is described first. Childhood physical abuse predicted anxiety, depression, and PTSD symptoms at age 29.2. Childhood physical abuse did not predict coping strategies at age 29.2 or problem-focused or emotion-focused coping at age 39.5. Anxiety symptoms were the only potential mediator related to BMI and contrary to prediction were associated with lower BMI. Thus, although the direct effect of childhood physical abuse on adult BMI was positive in these analyses, the indirect effect of physical abuse on BMI through the anxiety was negative, indicating a specific type of mediation known as a suppressor effect (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002)

The single mediator analyses were followed-up with two multiple mediator models presented in Table 4. In the first model, in which symptoms types at age 29.2 were entered simultaneously the results showed that anxiety remained a mediator with a negative relation to BMI. In contrast to the single mediator models in Table 3, when considered in a multiple mediator model along with Generalized Anxiety, depression and PTSD symptoms positively mediated the association between physical abuse and BMI such that physical abuse was related to more of these symptoms and these symptoms in turn were related to higher BMI. Neither coping style at age 39.5 mediated the association between childhood physical abuse and BMI.

Mediation Models Moderated by Sex

To examine the influence of participant sex on the mediation model, conditional indirect effect models were tested. Results of each of the multiple mediation models moderated by sex are presented in Table 5. Among women, childhood physical abuse was significantly related to BMI ($t = 2.08$, $p < .05$, *direct effect* = 3.11) and generalized anxiety symptoms (still in a negative association) remained a significant mediator for the relation between physical abuse and adult BMI. Among men, there were no significant direct effects of childhood physical abuse on BMI ($t = 1.25$, $p > .10$, *effect* = 1.78) or significant mediation.

Depression symptoms, PTSD symptoms and coping strategies were not significant mediators for women or men in the multiple mediational models. Additionally, there were no significant sex by physical abuse interactions predicting the mediators or sex by mediators interactions predicting BMI (not shown). To ascertain that missing data were not significantly influencing the findings, the analyses were rerun in Mplus using Full Information Maximum Likelihood estimation (Muthen & Muthen, 1998-2004). This technique takes into consideration all the available data points and minimizes the impact of missing data. The size and direction of the effects were unchanged.

Discussion

Using a prospective cohort design involving children with documented cases of physical abuse and a comparison group who were followed up and assessed in middle adulthood, these findings support physical abuse as a risk factor for subsequent higher BMI in adulthood. The results also suggest that symptoms of anxiety, depression and PTSD may explain some of the association between physical abuse and BMI. However, these relationships are complex and for anxiety more pronounced for women than men.

We found that childhood physical abuse predicted Generalized Anxiety Disorder symptoms at age 29.2, but these symptoms predicted lower BMI at age 41.2. The direction of the association between anxiety and BMI was unexpected, given that some literature has reported positive associations between anxiety disorders and weight (Anderson et al., 2006; Hach et al., 2007; Scott et al., 2008; Simon et al., 2006). The designs of these studies differed considerably from the present study and their results do not present a consistent picture. Anderson et al. (2006), Simon et al. (2006), and Scott et al., (2008) used self-reported weight. Anderson et al. (2006) found the association only in women, not men. Simon et al. (2008) found the relationship for panic disorders or agoraphobia, not the Generalized Anxiety Disorder symptoms studied here. Scott et al. (2008) found an association between obesity and any anxiety disorders, but most strongly with PTSD. Hach et al. (2007) used measured weight and height; however, obesity in general was much less common in their German sample, anxiety was the only mental disorder associated with obesity, and this association was only found in obese men. One other study reported a negative association between measured BMI and anxiety in men and women ages 20-89, but elevated waist-to-hip ratio was associated with anxiety in men, after controlling for BMI and other relevant factors (Rivenes, Harvey, & Mykletun, 2009).

In the current study and in general (Brown, Campbell, Lehman, Grisham, & Mancill, 2001), generalized anxiety, depression, and PTSD are highly comorbid and when symptoms of generalized anxiety are taken into account, depression and PTSD explained some of the positive association between childhood physical abuse and higher BMI. The current findings suggest that there may be a more complex interaction of depression, anxiety, PTSD and BMI that is not well understood. The role of comorbidity between anxiety and depression or PTSD in relation to BMI has not been extensively studied. Contrary to the results of the present study, prior research has raised questions about whether anxiety uniquely contributes to BMI after depression has been taken into consideration (Strine et al., 2008).

One explanation for the disparate relations between symptoms of depression, PTSD and anxiety and BMI observed here may lie in the different associated risk for health behaviors. In a meta-analysis, depressed patients were found to be more likely than anxious patients to be non-compliant with medical treatment (DiMatteo et al., 2000), which may contribute to poorer health outcomes and BMI. Another possibility is that the somatic symptoms of depression and PTSD and possible underlying physiological mechanisms may contribute to higher BMI (Shulberg, McLelland & Burns, 1987; Kubanzky & Koenen, 2009). Future research on childhood maltreatment and BMI should consider comorbidities when examining mechanisms.

This study found differences in the relationships among physical abuse, symptoms of generalized anxiety, depression, PTSD and BMI for women and men. As with other medical conditions, such as heart disease (Leuzzi, Sangiorgi, & Modena, 2010), it may be that some risk factors and pathways for developing higher BMI in middle adulthood are sex specific. The current study found that the associations of childhood physical abuse were stronger for women than for men. In women, generalized anxiety disorder symptoms remained a significant mediator in the relation between childhood physical abuse and adult BMI. These results suggest generalized anxiety symptoms are implicated in understanding the link between early childhood physical abuse and adult BMI particularly for women. These findings are also consistent with previous research that has shown that women's body weight is more strongly linked with psychopathology than men's (Anderson et al., 2006). It is also possible that women are more willing to report their emotional and behavioral symptoms than men (Kroenke, & Spitzer, 1998). Yet another possibility is that women appear to be more easily affected by environmental (Gonzalez et al., 2009) and psychosocial factors (Anderson et al., 2006; Herring et al., 2013)

One advantage of the current study is the use of a comparison group that allows comparison of the physically abused children to children with similar demographic characteristics and from similar socio-economic backgrounds. This is particularly important because the average adult BMI of these participants was classified in the overweight/obese range. Because the sample was largely composed of children from lower socioeconomic status families and poorer neighborhoods and because poverty is a known risk factor for being overweight (Lee, Harris, & Gordon-Larsen, 2009), this characterization of the entire sample was not surprising. In other research with overweight individuals, BMI has been associated with poorer health outcomes (Papalia et al., 2010). However, our findings suggest that healthcare providers treating adults with histories of childhood physical abuse and those suffering from generalized anxiety, depression, and PTSD should be mindful of their risk for developing higher BMI in middle adulthood.

Limitations of this work are also important to note. First, the current analyses focus on early adulthood and not adolescent mediators. The developmental and physiological changes during adolescence make this age group particularly vulnerable to the onset of anxiety and depressive disorders (Paus, Keshavan, & Giedd, 2002). Therefore, because these mediators were assessed in adulthood, these findings do not take into account the onset of these processes. On the other hand, some empirical work suggests that the health effects of childhood physical abuse may not be manifest until later in adulthood and mediators such as

anxiety and depression may not emerge until late adolescence and early adulthood (Fagundes & Way, 2014; Repetti et al., 2002). Future research might examine multiple developmental periods in a longitudinal design to untangle these relations.

Another important limitation is the absence of a baseline measure of childhood BMI, a predictor of adult BMI and adult obesity (Freedman, 2005). In addition, outcomes associated with court cases of childhood physical abuse may not generalize to cases not reported to the courts or other official agencies or to cases of abuse that might have occurred in adolescence. Cases that come to the attention of courts over-represent families at the lower end of socioeconomic spectrum and may not be generalizable to cases of childhood physical abuse in families of higher socioeconomic status. These results may also not generalize to other types of child maltreatment. In addition, the unbalanced sample size may have contributed to lower power to detect significant findings in the moderated mediation models.

In light of the current findings and the lack of support for coping as a mediator, some speculation about other possible mechanisms that may explain the higher BMI in individuals with histories of childhood physical abuse is warranted. One possibility is that the relationship between childhood physical abuse and BMI is mediated by more chronic pain in adulthood such that increased weight may be the side effect of drug treatments. It is also possible that we need to examine eating-specific coping behaviors, such as overeating (Greenfield & Marks, 2009). Contextual factors that frequently accompany childhood physical abuse, such as environments marked by poverty and community violence (Margolin et al., 2009) or living in neighborhoods that offer fewer healthy food options and fewer opportunities to engage in physical activity (McNeill, Kreuter, & Subramanian, 2006), may also be contributing to weight gain. Childhood physical abuse may lead to impaired neurological functioning that underlies emotion regulation and impulsive behavioral tendencies (Becker-Blease & Freyd, 2008; Grassi-Oliveira, Ashy, & Stein, 2008; Repetti et al., 2002; Wilson et al., 2011), which may contribute to higher BMI.

Nonetheless, the results of this study contribute to our understanding of the long-term associations of childhood experiences with adult physical health by providing the first empirical test of hypothesized mediators between childhood physical abuse and BMI in adulthood. These findings reinforce the need for pediatricians and other professionals concerned about the development of children to recognize the heightened risk for physically abused children to have higher BMI in adulthood. The complex associations between symptoms of anxiety, depression, and PTSD and BMI suggest that future work should consider how mental health problems are translated into higher BMI in physically abused boys and girls.

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Table 1

Descriptive Statistics for the Sample Overall and Comparison and Physical Abuse Groups Separately

	Total M (SD) N= 427	Comparison M (SD) N=349	Physical Abuse M (SD) N=78
Generalized Anxiety Disorder symptoms (age 29)	3.94 (4.91)	3.72 (4.68)	4.94 (5.75)
Major Depressive Disorder symptoms (age 29)	3.27 (2.68)	3.16 (2.64)	3.74 (2.80)
Posttraumatic Stress Disorder symptoms (age 29)	4.75 (5.40)	4.30 (5.22)	6.81 (5.69)
Coping (age 29)	3.17 (0.36)	3.18 (0.35)	3.11 (0.42)
Problem Focused Coping (age 39.5)	21.42 (4.71)	21.65 (4.64)	20.37 (4.94)
Emotion Focused coping (age 39.5)	17.05 (4.85)	16.84 (4.87)	18.00 (4.70)
Body Mass Index (BMI) score	29.97 (7.80)	29.50 (7.12)	32.00 (10.07)
Age at 3 rd interview	41.15 (3.62)	41.11 (3.58)	41.33 (3.81)
<i>BMI categories</i>	<i>N (%)</i>	<i>N (%)</i>	<i>N (%)</i>
Underweight	7 (1.8)	6 (1.9)	1 (1.4)
Normal weight	95 (24.1)	79 (24.6)	16 (21.6)
Overweight	127 (32.2)	106 (33.0)	21 (28.4)
Obese	166 (42.0)	130 (40.5)	36 (48.6)
Self Reported Weight	73 (18.1)	55 (16.8)	18 (23.7)
Female	215 (50.4)	177 (50.7)	38 (48.7)
White	267 (66.3)	210 (63.4)	57 (79.2)

Note. *M* = mean; *SD* = standard deviation.

Table 2
Bivariate Correlations among Childhood Physical Abuse, Mediators, Body Mass Index, and Control Variables

	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Childhood Physical Abuse	-												
Mediators: Mean age 29													
2. Generalized Anxiety Symptoms	.08	-											
3. Major Depressive Symptoms	.06	.56**	-										
4. Posttraumatic Stress Symptoms	.18**	.36**	.42**	-									
5. Coping	-.07	-.07	-.10*		-								
Mediators: Mean age 39.5													
6. Problem Focused Coping	-.10*	.13**	.12*	.09	.20**	-							
7. Emotion Focused Coping	.09	.24**	.29**	.26**	.15**	.00	-						
Outcome: Mean age 40.5													
8. Body Mass Index	.13*	-.10*	.01	.10*	.00	-.01	-.03	-					
Control Variables													
9. Age	.02	-.04	-.04	-.02	.02	.03	-.08	.10*	-				
10. Race (White)	.14**	.05	-.02	-.04	.16**	-.09	-.05	-.10*	-.11*	-			
11. Sex (Female)	-.03	.15**	.11**	.14**	.10*	.12*	.16**	.13**	.05	-.04	-		
12. Smoking	-.05	-.04	-.10*	-.14**	.05	.02	-.04	.10*	-.04	-.07	.08	-	
13. Self-reported Weight	.07	-.11*	-.11*	.03	-.02	-.03	-.03	.17**	.06	.01	-.11*	-.04	-

Note.

*
p < .05

**
p < .01

Table 3

Single Mediation Models: Childhood Physical Abuse (Independent Variable) Predicting BMI (Dependent Variable) via the Potential Mediating Variables Entered into the Models Separately

Mediating Variable (MV)	Effect of IV on MV (SE)	Effect of MV on DV (SE)	Total effect (SE)	Direct Effect (SE)	Indirect Effect (SE)	95% CI of the indirect effect
Age 29						
Generalized Anxiety Disorder symptoms (n = 370)	1.76 ^{**} (.66)	-.18 [*] (.08)	2.49 [*] (1.02)	2.82 ^{**} (1.03)	-.32 (.21)	[-.91, -.04]
Major Depressive Disorder symptoms (n = 370)	.81 [*] (.36)	.02 (.15)	2.49 [*] (1.02)	2.47 [*] (1.03)	.02 (.14)	[-.24, .31]
Posttraumatic Stress Disorder symptoms (n = 369)	2.82 ^{**} (.72)	.07 (.08)	2.47 [*] (1.03)	2.26 [*] (1.05)	.21 (.23)	[-.18, .77]
Coping (n = 369)	-.10 (.05)	-.42 (1.09)	2.47 ^{**} (1.03)	2.43 [*] (1.04)	.04 (.13)	[-.15, .43]
Age 39.5						
Problem Focused Coping (n = 344)	-1.29 (.67)	-.08 (.09)	2.30 [*] (1.08)	2.21 [*] (1.08)	.10 (.13)	[-.07, .50]
Emotion Focused Coping (n = 344)	1.30 (.68)	.09 (.09)	2.30 [*] (1.08)	2.18 [*] (1.08)	.12 (.13)	[-.04, .55]

Note. IV = independent variable; MV = mediating variable; DV = dependent variable; SE = standard error; CI = confidence interval; Analyses control for age, sex, race, smoking, and self-reported weight; PROCESS Model 4.

* p < .05

** p < .01.

Table 4

Multiple Mediators Model: Childhood Physical Abuse (Independent Variable) Predicting BMI (Dependent Variable) via the Potential Mediating Variables Assessed in Two Models (Psychopathology and Coping)

Mediating Variable (MV)	Effect of IV on MV (SE)	Effect of MV on DV (SE)	Indirect Effect (SE)	95% CI of the indirect effect	Direct Effect (SE)
Model 1 (n=369)					
Generalized Anxiety Disorder symptoms	1.57 (.66)	-.31 (.10)	-.49* (.29)	[-1.10, -.13]	2.41* (1.02)
Major Depressive Disorder symptoms	.85 (.36)	.26 (.19)	.22* (.19)	[0.002, .68]	
Posttraumatic Stress Disorder symptoms	2.82 (.72)	.12 (.08)	.34* (.27)	[0.020, .91]	
Model 2 (n=344)					
Problem Focused Coping	-1.29 (.67)	-.09 (.09)	.12 (.14)	[-0.02, .47]	2.05 [†] (1.09)
Emotion Focused Coping	1.30 (.68)	.11 (.09)	.14 (.14)	[-.004, .46]	

Note. IV = independent variable; MV = mediating variable; DV = dependent variable; CI = Confidence Interval; SE = standard error; Controlling for age, sex, race, smoking and weight report; PROCESS Model 4.

[†] $p < .10$

* $p < .05$

Table 5

Conditional Indirect Effects of Childhood Physical Abuse on BMI Through Potential Mediators by Sex

	Indirect Effect	Boot SE	95% CI of the conditional indirect effect
Model 1 (n = 369)			
Generalized Anxiety Disorder symptoms			
Men	-.31	.30	[-1.16, 0.16]
Women	-.69 [*]	.43	[-1.89, -0.05]
Major Depressive Disorder symptoms			
Men	.11	.16	[-0.07, 0.69]
Women	.32	.28	[-0.05, 1.13]
Posttraumatic Stress Disorder symptoms			
Men	.25	.22	[-0.02, 0.83]
Women	.43	.35	[-0.03, 1.53]
Model 2 (n = 167)			
Problem Focused Coping			
Men	.10	.15	[-0.05, 0.70]
Women	.14	.18	[-0.06, 0.82]
Emotion Focused Coping			
Men	.22	.20	[-0.06, 0.76]
Women	.07	.15	[-0.11, 0.59]

Note. Boot = bootstrap analysis (1000 samples); SE = standard error; CI = confidence interval; Controlling for age, race, smoking, and weight report; PROCESS Model 8.

^{*}
 $p < .05$.