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Associations Between Body Mass Index, Post-Traumatic Stress Disorder, and Child Maltreatment In Young Women

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Abstract

The objective of this study was to examine interrelationships between child maltreatment, post-traumatic stress disorder (PTSD) and body mass index (BMI) in young women. We used multinomial logistic regression models to explore the possibility that PTSD statistically mediates or moderates the association between BMI category and self-reported childhood sexual abuse (CSA), physical abuse (CPA), or neglect among 3699 young women participating in a population-based twin study. Obese women had the highest prevalence of CSA, CPA, neglect, and PTSD ($p < 0.001$ for all). Although all three forms of child maltreatment were significantly, positively associated with overweight and obesity in unadjusted models, only CSA was significantly associated with obesity after adjusting for other forms of maltreatment and covariates (OR = 2.21, 95% CI: 1.63, 3.00). CSA and neglect, but not CPA, were associated with underweight in unadjusted models; however, after adjusting for other forms of maltreatment and covariates, the associations were no longer statistically significant (OR = 1.43; 95% CI: 0.90-2.28 and OR = 2.16; 95% CI: 0.90-5.16 for CSA and neglect, respectively). Further adjustment for PTSD generally resulted in modest attenuation of effects across associations of child maltreatment forms with BMI categories, suggesting that PTSD may, at most, be only a weak partial mediator of these associations. Future longitudinal studies are needed to elucidate the mechanisms linking CSA and

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obesity and to further evaluate the role of PTSD in associations between child maltreatment and obesity.

Keywords

BMI; child maltreatment; obesity; PTSD

Introduction

One-fifth to more than one-third of women report a history of child maltreatment, such as childhood sexual abuse (CSA), childhood physical abuse (CPA) and/or child neglect (Dube et al., 2003; MacMillan, Tanaka, Duku, Vaillancourt, & Boyle, 2013). Child maltreatment is associated with a wide variety of adverse physical and mental health outcomes, including post-traumatic stress disorder (PTSD) (Chou, 2012; Cougle, Timpano, Sachs-Ericsson, Keough, & Riccardi, 2010; Molnar, Buka, & Kessler, 2001; Sugaya et al., 2012). For example, in a prospective study 41.7% of female participants with court substantiated child maltreatment went on to develop PTSD (Koenen & Widom, 2009), and 45.8% and 34.9% of National Comorbidity Survey Replication respondents who met criteria for PTSD in their lifetimes reported physical or sexual abuse, respectively. (Cougle et al., 2010).

Child maltreatment has also been linked to weight gain and obesity (Alvarez, Pavao, Baumrind, & Kimerling, 2007; Bentley & Widom, 2009; Boynton-Jarrett, Rosenberg, Palmer, Boggs, & Wise, 2012; Chartier, Walker, & Naimark, 2009; Mamun et al., 2007; Noll, Zeller, Trickett, & Putnam, 2007; Shin & Miller, 2012; Williamson, Thompson, Anda, Dietz, & Felitti, 2002). Although a recent meta-analysis demonstrated a significant positive association between obesity and CSA, CPA, and a “general abuse,” a category that included child neglect (Hemmingsson, Johansson, & Reynisdottir, 2014), many of the studies included only examined one form of child maltreatment or examined forms of child maltreatment separately. Given that many who experience any form of child maltreatment experience more than one form (Briere & Elliot, 2003; Chu & Dill, 1990; McCutcheon et al., 2010), it will only be possible to determine whether an association between a single form of child maltreatment and obesity is direct, rather than due to other co-occurring forms of maltreatment, by jointly estimating the effects of all types of maltreatment in the statistical model.

The majority of studies on associations between child maltreatment and obesity have used a binary outcome variable, comparing obese versus all non-obese individuals. This classification may not be ideal, as people who are overweight (Mamun et al., 2007; Roenholt, Beck, Karsberg, & Elklit, 2012) and underweight (Veldwijk, Proper, Hoeven-Mulder, & Bemelmans, 2012) have also been shown to report elevated rates of child maltreatment histories. Therefore, studies using binary outcome variables likely underestimate the strength of association between child maltreatment and obesity relative to normal weight. The use of a multi-category outcome variable would allow for examination of relationships between forms of child maltreatment and under- and over-weight, as well as obesity.

PTSD has also been found to be associated with obesity (Kubzansky et al., 2013; Perkonig, Ohashi, Stein, Kirschbaum, & Wittchen, 2009; Scott, McGee, Wells, & Oakley Browne, 2008). Given that PTSD is associated both with child maltreatment and obesity, it is possible that observed associations between child maltreatment and obesity may be due – at least in part – to comorbid PTSD, or that PTSD may serve as a moderator of the relationship between child maltreatment and obesity. Surprisingly, however, research that examines child maltreatment, PTSD and obesity simultaneously is limited (c.f. (Roenholt et al., 2012)). Therefore, the objective of this study was to examine interrelationships between child maltreatment (CSA, CPA and neglect), PTSD and BMI in a well-characterized, population-ascertained sample of young women.

Methods

Sample

The Missouri Adolescent Female Twin Study (MOAFTS) is a study of female twin pairs identified from state birth records as born in Missouri between July 1st 1975 and June 30th 1985 to a mother who was a state resident. Participants included both African American (AA: 14.6%) and European/other Ancestry (EA: 85.4 %) women, reflecting the racial distribution in the state during this time period. The Wave 1 (baseline) interview was conducted with the twins beginning in 1995 (n = 3,258; median age = 15) (Glowinski, Madden, Bucholz, Lynskey, & Heath, 2003). When possible, interviews were also conducted with a parent (usually the mother) at the time the twins entered the study. Two years after the Wave 1 interviews, retest (Wave 3) interviews were conducted with a subset of participants (n=1,370; median age = 19). (Data were not drawn from the brief Wave 2 interview, as it did not cover all domains of interest.) The first full-length young adult follow-up interview (Wave 4) was conducted an average of six years after the baseline assessment (n=3,787; median age = 22) when all participants were 18 years of age. Unless they or their families had asked not to be re-contacted, all individuals from the original sampling frame were invited to participate at Wave 4, even if they had not participated at Wave 1 (non-participation at Wave 1 may have been due to parent refusal for twins of minor age, twin refusal or because we were unable to locate the family at that time). Wave 5 interviews were administered approximately two years later (n=3,428; median age = 24). All protocols were approved by the institutional review board at Washington University School of Medicine. Additional details regarding the sample are available elsewhere (Glowinski et al., 2003; Heath et al., 2002; Heath et al., 1999; Waldron, Bucholz, Lynskey, Madden, & Heath, 2013).

Assessment

Twins were interviewed at each wave of data collection using a telephone adaptation of the Semi-Structured Assessment for the Genetics of Alcoholism (SSAGA), a comprehensive structured psychiatric diagnostic instrument shown to be a reliable and valid diagnostic assessment of lifetime DSM-IV psychiatric disorders (Bucholz et al., 1994; Hesselbrock, Mese, Bucholz, Schuckit, & Hesselbrock, 1999). BMI at Wave 4 was calculated from self-reported height and weight, which were queried in the zygosity section of the interview, in which each twin also provided an estimate of her co-twin's height and weight. Respondents'

BMI based on self-reported height and weight was highly correlated with that calculated based on their co-twins' reports ($r = .90$). BMI was categorized using standard adult BMI cutoffs: underweight ($<18.5 \text{ kg/m}^2$), normal weight ($18.5\text{-}24.9 \text{ kg/m}^2$; referent), overweight ($25.0\text{-}29.9 \text{ kg/m}^2$), and obese ($\geq 30 \text{ kg/m}^2$).

PTSD—As part of the Wave 4 telephone interview, participants were administered a standard traumatic event checklist (adapted from the National Comorbidity Survey (Kessler, Sonnega, Evelyn, Hughes, & Nelson, 1995)) with nine items: rape; sexual molestation; serious childhood neglect; CPA; serious physical attack or assault; threatened with a weapon, held captive, or kidnapped; fire, flood, or natural disaster; life-threatening accident; and witnessing someone being badly injured or killed. Respondents endorsing one or more traumatic events in the trauma checklist ($n = 1,684$; 44.5% of the sample) were asked which of the events was the most disturbing and if they had experienced 'intense fear, helplessness, or horror' following the event (Criterion A for DSM-IV PTSD). Women responding 'yes' were asked about PTSD symptoms with respect to that event. Those who responded 'no' and endorsed only one event from the trauma checklist were coded negative for PTSD. Respondents answering 'no' who endorsed other events on the trauma checklist were asked the Criterion A question for a second event, with 'No' responses coded negative for PTSD. Criteria B (one of five re-experiencing symptoms), C (three of seven avoidance symptoms), and D (two of five arousal symptoms) diagnostic questions were asked only if the preceding criterion was met. Respondents were assigned a diagnosis of PTSD if they met Criteria A through D and reported clinically significant distress or impairment in social or occupational functioning and persistence of symptoms for one month or longer.

Child maltreatment—Respondents were coded positive for a given type of child maltreatment if they endorsed any of the interview items within that category (CSA, CPA, and neglect; see Table 1 for list of items) at any wave of data collection, and if they reported that the event first occurred before age 16. In addition to examining each form of child maltreatment separately, we also conducted analyses using a count of forms of maltreatment (0, 1, 2 and 3 forms).

Covariates—Demographic and environmental variables assessed in one or more waves of MOAFTS data collection and identified from the literature as being associated with BMI and child maltreatment were included as covariates in logistic regression models. Race/ethnicity (Flegal, Carroll, Kit, & Ogden, 2012; Sedlak et al., 2010) was that reported by the mother on the birth record. Early menarche (< 12 years vs. ≥ 12 years), (Black & Klein, 2012; Joinson, Heron, Lewis, Croudace, & Araya, 2011) was coded from the age at menarche reported by the twins at Wave 4. Information regarding traumatic experiences (other than child maltreatment) with first occurrence < 16 years was taken from responses on the trauma checklist (see above). Maternal and paternal education levels (used as an indicator of family socioeconomic status, e.g., (Hasin, Goodwin, Stinson, & Grant, 2005; Kessler et al., 2003)), were obtained from parental self-reports or from a co-parent report if only one parent completed an interview, with twin report of parental education from Wave 5 (the only twin interview to query all respondents regarding parental education) substituted only when data were not available from either parent. Parental education was categorized

into a three-level variable and included in multivariable models as a set of indicator variables (< high school and high school [referent], and missing maternal (n=93) or paternal (n= 159) education data). History of parental separation (Amato & Keith, 1991) before the twins were 18 years old was coded from items included in the parent and twin interviews (Waves 1, 3, 4, and 5), with the latter only used when parental interviews were not available. Due to limitations of the interview data it was not possible to date the separation more precisely than < 18 years for a portion of the sample; (see (Waldron et al., 2013) for details). Finally, maternal and paternal alcohol problems (Anda et al., 2002), were coded from parent or twin Wave 4 interviews. A parent was coded “definite” for alcoholism if (1) the parent met criteria for DSM-IV alcohol dependence through self-report, or (2) two other informants (co-parent and at least one twins or both twins) reported that the parent had problems with alcohol, defined as the co-parent reporting that the parent had three alcohol dependence symptoms or a twin reporting that drinking had ever caused the parent “problems with health, family, job or police, or other problems” and that the parent was an “excessive drinker” (asked of the twins) (Waldron et al., 2013). A second “probable” category included those parents with positive reports from a single informant. Thus, maternal and paternal alcohol problems were each included in logistic regression models as a set of indicator variables (alcohol problems present, alcohol problems probable, and no alcohol problems [referent]) (Waldron et al., 2012).

Data analysis

Data were analyzed using Stata Version 9 (StataCorp, 2005). Survey commands were used for the analysis of bivariate associations. Under the survey command, the Pearson χ^2 statistic is corrected for relatedness of members of twin pairs using the Rao and Scott (1984) second order correction, converting the Pearson χ^2 into an F statistic (Rao & Scott, 1984). For multinomial logistic regression models with BMI category at Wave 4 as the dependent variable (reference category: normal weight), Huber-White robust variance estimation was used to adjust standard errors for the non-independence of observations inherent in twin data (StataCorp, 2005).

Analyses proceeded in several steps. First, we compared weight categories on covariates and CSA, CPA, neglect, and PTSD (see Tables 2 & 3). Second, we estimated multinomial logistic regression models with all three child maltreatment variables but no covariates. Third, we added covariates with p-values < .20 in bivariate analyses to the model to create a fully adjusted model. Fourth, we added PTSD to the full model and compared the ORs for child maltreatment variables in this model to the previous model to evaluate whether it appeared that PTSD explained part or all of the associations between child maltreatment variables and BMI category, calculating the percent change in ORs using the formula:

$$\frac{OR_{model\ without\ PTSD} - OR_{model\ with\ PTSD}}{OR_{model\ without\ PTSD} - 1} \times 100\%$$

Results

The majority of the sample had BMIs in the normal weight category. Eighteen percent (18.03%) of women were overweight, 13.44% were obese and 6.49% were underweight. Approximately one quarter of the sample (26.76%) reported at least one form of child maltreatment. Of women reporting any child maltreatment, the majority (73.25%) reported one form, 22.41% reported two forms, and 4.3% reported three forms of child maltreatment. Physical abuse was the most commonly reported form of child maltreatment (20.49%), followed by sexual abuse (12.54%) and neglect (2.87%). Approximately four percent (3.92%) of women met criteria for PTSD. Although a large majority of these women reported child maltreatment (79.31%), only 11.35% of women who reported child maltreatment met criteria for PTSD. Characteristics of the sample by BMI category are shown in Table 2. There were significant differences by BMI category for the majority of the variables examined ($p < .01$).

CSA, CPA, neglect, and PTSD were all significantly associated with BMI category, with the lowest prevalence among normal weight women and the highest among obese women ($p < .001$ for all; see Table 3). Results from multinomial logistic regression models are shown in Table 4). All three child maltreatment variables were significantly associated with overweight and obesity after adjusting for one another; however, point estimates were higher for associations with obesity than with overweight. Although the ORs for associations of CSA and neglect with underweight were of comparable or greater magnitude than for associations between these variables and overweight and obesity, they were not statistically significant. Adjusting for covariates resulted in substantial attenuation of the effect sizes for the majority of associations between child maltreatment variables and BMI categories in the model. Only the OR for the association between CSA and obesity remained statistically significant (OR = 2.21, 95% CI: 1.63-3.00). The magnitude of the ORs for associations of child maltreatment variables with underweight and obesity was changed by less than 10% (range: -1.80% - 8.51%) after adding PTSD to the model with covariates. PTSD was only significantly associated with overweight (OR = 1.69; 95% CI: 1.07-2.69), after adjusting for child maltreatment and other covariates. Taken together, these findings suggest that PTSD may be a mild partial mediator of the association between child maltreatment and BMI category.

We conducted additional analyses parameterizing child maltreatment as a count variable (number of forms of child maltreatment reported). Since post hoc tests of differences in ORs for those reporting one vs. two forms of maltreatment in adjusted models were not statistically significant ($p > 0.05$ for all), these categories were collapsed into a new variable: 3, 1-2 or 0 forms of maltreatment. Detailed results from multinomial logistic regression models are shown in the supplementary table. After adjusting for covariates, women who reported all three forms of maltreatment had greater odds of being underweight (OR = 4.66, 95% CI: 1.21-17.91) and obese (OR = 4.81, 95% CI: 1.57-9.26) than those who did not report maltreatment, as did women who reported 1-2 forms of maltreatment (OR = 1.48, 95% CI: 1.05-2.09 and OR = 1.55, 95% CI: 1.20-2.00 for underweight and obesity, respectively). Although overweight was also significantly associated with reporting 1-2 forms of maltreatment (OR = 1.32; 95% CI: 1.06-1.66), the OR for three forms of

maltreatment was not statistically significant (OR = 1.70; 95% CI: 0.66-4.36), despite being of greater magnitude than that for 1-2 forms of maltreatment. As with the models that included the specific forms of child maltreatment, the addition of PTSD attenuated the ORs by <10% for underweight and obesity and >10% for overweight (20.00% and 15.62% for 3 and 1-2 forms of child maltreatment, respectively).

Discussion

We found a strong association between CSA and obesity. Although CSA, CPA and neglect were each independently associated with underweight, overweight (CSA and CPA only) and obesity relative to normal weight, the association between CSA and obesity was the only one that remained statistically significant after adjusting for covariates, including other adverse childhood experiences that often occur in the same context of child maltreatment and that also have been posited to play a role in the development of obesity (Hemmingsson, 2014). It has been suggested that some CSA survivors may become overweight or obesity as an adaptive response to CSA, with excess weight seen as a way of putting off potential sexual partners and/or abusers (e.g., (Wiederman, Sansone, & Sansone, 2008)). In addition, it has been posited that women who have been abused may engage in binge eating as form of self-medication for negative affect associated with all forms of CAN, and that this binge eating leads to obesity.(de Zwaan, 2001; Grilo & Masheb, 2001; Grucza, Przybeck, & Cloninger, 2007; Pine, Goldstein, Wolk, & Weissman, 2001; Rohde et al., 2008). Child maltreatment could also be associated with underweight due to a higher prevalence of anorexia nervosa among women with maltreatment histories – particularly survivors of CSA (Rayworth, Wise, & Harlow, 2004).

We found that the associations of CSA and neglect with underweight were no longer statistically significant after adjusting for covariates; however, the strength of these associations did not diminish markedly in adjusted models, and the magnitude of the association between neglect and underweight was fairly large (fully adjusted OR=2.14; see Table 4), suggesting that there was insufficient statistical power to detect associations with underweight, which had a relatively low prevalence in our sample (6.49%). The prevalence of neglect was also low in our sample (2.87%). Since the study of the consequences of child maltreatment was not one of the original aims of the MOAFTS, the assessment of child neglect limited to two interview questions about “serious” neglect that were included as part of the home environment and trauma assessment sections, respectively (see Table 1 for wording). Although the prevalence of neglect in our study is similar to estimates from other studies that used the same trauma assessment, e.g., (Kessler et al., 2010), it is very low compared to previous studies using retrospective measures of child neglect that included multiple questions (Dube et al., 2003; Shin & Miller, 2012). Further, only 10.46% of women reporting any form of child maltreatment reported neglect, compared to over three-quarters of officially reported cases of child maltreatment involving neglect (U.S. Department of Health and Human Services, 2012), suggesting that there are many false negatives in our study. The likely effect of this misclassification, however, would be that our estimates are biased toward the null. Given the aforementioned limitations, further exploration of associations between underweight and neglect is warranted.

It is somewhat difficult to compare our results to those from other studies due to differences in operationalizing BMI and child maltreatment. Nevertheless, our finding that CSA was associated with obesity is similar to findings from several previous studies using comparison groups that included overweight and/or underweight participants (Alvarez et al., 2007; Chartier et al., 2009; Mamun et al., 2007; Noll et al., 2007) and to those from a recently published meta-analysis (Hemmingsson et al., 2014). That we did not find a significant association between overweight or obesity and CPA contradicts the results of the meta-analysis; however, the differences in findings is likely explained by the fact that, unlike many studies included in the meta-analysis, we adjusted our analyses for other forms of maltreatment, as well as other childhood adversities (e.g. (Hemmingsson et al., 2014)). Our findings that women reporting any form of child maltreatment had elevated odds of obesity and that those reporting all three forms of maltreatment were at greatest risk are also consistent with results from some previous studies (Boynton-Jarrett et al., 2012; Williamson et al., 2002).

That this and other studies using multi-category BMI variables found significant associations between child maltreatment and PTSD, as well as under- and overweight, suggests that effect sizes from previous studies of associations between child maltreatment or PTSD and obesity that used binary obesity variables may be underestimates. In addition, estimates from studies using continuous measures of BMI may be inaccurate if the assumption of linear relationship was not tested and corrected for where necessary.

To our knowledge, only one other study has simultaneously considered child maltreatment, PTSD and BMI (Roenholt et al., 2012); however, since modeling results were not given separately by type of maltreatment, comparisons are not possible. As established in prior studies examining bivariate associations, we found that PTSD was independently associated with child maltreatment (Chen et al., 2010; Chou, 2012; Cogle et al., 2010; Jonas et al., 2011; Molnar et al., 2001; Sugaya et al., 2012) and non-normal BMI category (Kubzansky et al., 2013; Perkonig et al., 2009; Scott et al., 2008). The addition of PTSD to the model predicting BMI category, however, resulted in modest attenuation of the strength of these associations, suggesting that PTSD may, at best, be a weak partial statistical mediator of associations between child maltreatment and BMI. Notably, approximately 60% of women with PTSD nominated neglect, physical abuse, or sexual trauma as the most disturbing event they had experienced; symptoms of PTSD were assessed with respect to other traumatic events for the remaining women.

Limitations

The reader should keep in mind several limitations in addition to those mentioned above when interpreting the results from this study. First, because participants were already of median age 15 years at Wave I of MOAFTS, it was not possible to determine the temporal ordering of onset of current BMI category relative to onset of child maltreatment and/or PTSD for many of the women in the sample. It is quite possible that onset of non-normal weight could have occurred prior to the first occurrence of child maltreatment for the majority of participants given that 80% of substantiated cases of child abuse and neglect are in children younger than age 15 (U.S. Department of Health and Human Services, 2012),

and the prevalence of obesity in females increases dramatically with age (Ogden, Carroll, Kit, & Flegal, 2012). Since the mean age at onset of PTSD in our sample was just under 14 and abuse and neglect are common precipitating events that by definition occur during childhood, it is very unlikely that first child maltreatment events followed PTSD onset. Second, BMI was derived from self-reported height and weight. Although objectively measured height and weight would have been ideal, data on self-reported height and weight has been found to correspond highly with actual height and weight in young women (Brunner Huber, 2007; Goodman, Hinden, & Khandelwal, 2000). Respondents' BMI based on self-reported height and weight was highly correlated with that calculated based on their co-twin's report ($r=.90$), showing strong rater agreement with self-reports. Third, this study used retrospective report of child maltreatment, which has at times been criticized because of the potential for measurement error (Widom, Raphael, & DuMont, 2004). It is important to note, however, that physicians and mental health clinicians identify a history of child maltreatment in their patients through retrospective self-report, and thus findings from studies using this methodology are potentially of greater relevance in clinical settings than evidence from studies that ascertain child maltreatment cases prospectively. Further, even in the case of measurement error, if the proportion of individuals misclassified as false negatives using retrospective report (which likely far exceed the number of false positives, e.g., (Hardt & Rutter, 2004)) does not differ between BMI categories, estimates would be biased toward the null, decreasing the probability of spurious findings. It is acknowledged that there is evidence that individuals with certain outcomes (e.g. drug dependence (Widom, Weiler, & Cottler, 1999)) are more likely to retrospectively report a history of child maltreatment that was documented in childhood than those without such outcomes, thus biasing estimates away from the null.

However, significant, positive associations between child maltreatment and obesity have been reported from studies using retrospective reporting of child maltreatment in adulthood (e.g., (Chartier et al., 2009; Dube, Anda, Felitti, Edwards, & Croft, 2002)) as well as those ascertaining child maltreatment cases from official records (e.g., (Bentley & Widom, 2009; Noll et al., 2007)), indicating that this type of differential misclassification is less likely with respect to obesity. Fourth, the MOAFTS interviews did not assess emotional and verbal abuse; our results may have differed had these forms of child maltreatment been included in our models. Finally, we conducted numerous statistical tests. Since many of these tests were not independent of one another, we elected not to correct for multiple testing; however, readers may want to keep the possibility of type I error in mind when considering the results of our study.

Conclusions

CSA is associated with obesity in women, independently from other forms of child maltreatment, childhood traumas and PTSD. In addition, women reporting all three forms of child maltreatment (CSA, CPA, and neglect) are at particularly high risk of obesity compared to those reporting fewer or no forms of child maltreatment. PTSD may serve as a partial mediator of associations between child maltreatment and BMI category. Future studies should use longitudinal data to determine whether PTSD is a true mediator of these associations, examine other forms of psychopathology – particularly eating disorders – as

additional potential mediators and/or moderators of associations between child maltreatment and non-normal BMI category, and continue to explore potential psychological and biological mechanisms by which child maltreatment and BMI are linked.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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References

- Alvarez J, Pavao J, Baumrind N, Kimerling R. The Relationship Between Child Abuse and Adult Obesity Among California Women. *American Journal of Preventive Medicine*. 2007; 33(1):28–33. [PubMed: 17572308]
- Amato PR, Keith B. Parental divorce and the well-being of children: A meta-analysis. *Psychological Bulletin*. 1991; 110(1):26–46. [PubMed: 1832495]
- Anda RF, Whitfield CL, Felitti VJ, Chapman D, Edwards VJ, Dube SR, Williamson DF. Adverse childhood experiences, alcoholic parents, and later risk of alcoholism and depression. *Psychiatric Services*. 2002; 53:1001–1009. [PubMed: 12161676]
- Bentley TS, Widom CS. A 30-year follow-up of the effects of child abuse and neglect on obesity in adulthood. *Obesity*. 2009; 17:1900–1905. [PubMed: 19478789]
- Black S, Klein DN. Early menarcheal age and risk for later depressive symptomatology: the role of childhood depressive symptoms. *Journal of Youth and Adolescence*. 2012; 41(9):1142–1150. [PubMed: 22447395]
- Boynton-Jarrett RB, Rosenberg L, Palmer JR, Boggs DA, Wise LA. Child and Adolescent Abuse in Relation to Obesity in Adulthood: The Black Women's Health Study. *Pediatrics*. 2012; 130:245–253. [PubMed: 22753562]
- Briere J, Elliot DM. Prevalence and symptomatic sequelae of self-reported childhood physical and sexual abuse in a general population sample of men and women. *Child Abuse & Neglect*. 2003; 27:1205–1222. [PubMed: 14602100]
- Brunner Huber LR. Validity of self-reported height and weight in women of reproductive age. *Maternal and Child Health Journal*. 2007; 11:137–144. [PubMed: 17066316]
- Bucholz KK, Cadoret R, Cloninger C, Dinwiddie SH, Hesselbrock VM, Nurnberger JI, et al. Schuckit MA. A new, semi-structured psychiatric interview for use in genetic linkage studies: A report of the reliability of the SSAGA. *Journal of Studies on Alcohol*. 1994; 55:149–158. [PubMed: 8189735]
- Chartier MJ, Walker JR, Naimark B. Health risk behaviors and mental health problems as mediators of the relationship between childhood abuse and adult health. *Am J Public Health*. 2009; 99(5):847–854. [PubMed: 18703446]
- Chen LP, Murad MH, Paras ML, Colbenson KM, Sattler AL, Goranson EN, et al. Zirakzadeh A. Sexual abuse and lifetime diagnosis of psychiatric disorders: Systematic review and meta-analysis. *Mayo Clinic Proceedings*. 2010; 85(7):618–629. [PubMed: 20458101]
- Chou KL. Childhood sexual abuse and psychiatric disorders in middle-aged and older adults: evidence from the 2007 Adult Psychiatric Morbidity Survey. *Journal of Clinical Psychiatry*. 2012; 73(11):e1365–e1371. [PubMed: 23218165]
- Chu JA, Dill DL. Dissociative symptoms in relation to childhood physical and sexual abuse. *American Journal of Psychiatry*. 1990; 147(7):887–892. [PubMed: 2104510]
- Cougle JR, Timpano KR, Sachs-Ericsson N, Keough ME, Riccardi CJ. Examining the unique relationships between anxiety disorders and childhood physical and sexual abuse in the National Comorbidity Survey-Replication. *Psychiatry Research*. 2010; 177:150–155. [PubMed: 20381878]

- de Zwaan, Martina. Binge eating disorder and obesity. *International Journal of Obesity*. 2001; 25(Suppl 1):S51–S55. [PubMed: 11466589]
- Dube SR, Anda RF, Felitti VJ, Edwards VJ, Croft JB. Adverse childhood experiences and personal alcohol abuse as an adult. *Addictive Behaviors*. 2002; 27:713–725. [PubMed: 12201379]
- Dube SR, Felitti V, Dong M, Chapman DP, Giles WH, Anda RF. Childhood abuse, neglect, and household dysfunction and the risk of illicit drug use: The Adverse Childhood Experiences Study. *Pediatrics*. 2003; 111(3):564–572. [PubMed: 12612237]
- Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of Obesity and Trends in the Distribution of Body Mass Index Among US Adults, 1999–2010. *Journal of the American Medical Association*. 2012; 307(5):491–497. [PubMed: 22253363]
- Glowinski AL, Madden PA, Bucholz KK, Lynskey MT, Heath AC. Genetic epidemiology of self-reported lifetime DSM-IV major depressive disorder in a population-based twin sample of female adolescents. *Journal of Child Psychology and Psychiatry*. 2003; 44(7):988–996. [PubMed: 14531581]
- Goodman E, Hinden BR, Khandelwal S. Accuracy of teen and parental reports of obesity and body mass index. *Pediatrics*. 2000; 106(1):52–58. [PubMed: 10878149]
- Grilo CM, Masheb RM. Childhood psychological, physical, and sexual maltreatment in outpatients with binge eating disorder: Frequency and associations with gender, obesity, and eating-related psychopathology. *Obesity Research*. 2001; 9(5):320–325. [PubMed: 11346674]
- Gruzca RA, Przybeck TR, Cloninger CR. Prevalence and correlates of binge eating disorder in a community sample. *Comprehensive Psychiatry*. 2007; 48:124–131. [PubMed: 17292702]
- Hardt J, Rutter M. Validity of adult retrospective reports of adverse childhood experiences: review of the evidence. *Journal of Child Psychology and Psychiatry*. 2004; 45(2):260–273. [PubMed: 14982240]
- Hasin, Deborah S.; Goodwin, Renee D.; Stinson, Frederick S.; Grant, Bridget F. Epidemiology of major depressive disorder: Results from the National Epidemiologic Survey on Alcoholism and Related Conditions. *Archives of General Psychiatry*. 2005; 62:1097–1106. [PubMed: 16203955]
- Heath AC, Howells William, Bucholz KK, Glowinski AL, Nelson Elliot C, Madden PAF. Ascertainment of a Mid-Western US female adolescent twin cohort for alcohol studies: Assessment of sample representativeness using birth record data. *Twin Research*. 2002; 5(2):107–112. [PubMed: 11931688]
- Heath AC, Madden PAF, Grant JD, McLaughlin TL, Todorov AA, Bucholz KK. Resiliency factors protecting against teenage alcohol use and smoking: influences of religion, religious involvement and values, and ethnicity in the Missouri Adolescent Female Twin Study. *Twin Research*. 1999; 2:145–155. [PubMed: 10480749]
- Hemmingsson E. A new model of the role of psychological and emotional distress in promoting obesity: conceptual review with implications for treatment and prevention. *Obesity Reviews*. 2014; 15:769–779. [PubMed: 24931366]
- Hemmingsson E, Johansson A, Reynisdottir S. Effects of childhood abuse on adult obesity: A systematic review and meta-analysis. *Obesity Reviews*. 2014; 10.1111/obr.12216
- Hesselbrock MN, Mesa CE, Bucholz KK, Schuckit MA, Hesselbrock VM. A validity study of the SSAGA: a comparison with the SCAN. *Addiction*. 1999; 94:1361–1370. [PubMed: 10615721]
- Joinson C, Heron J, Lewis G, Croudace T, Araya R. Timing of menarche and depressive symptoms in adolescent girls from a UK cohort. *British Journal of Psychiatry*. 2011; 198:17–23. [PubMed: 21200072]
- Jonas S, Bebbington P, McManus S, Meltzer H, Jenkins R, Kuipers E, et al. Brugha T. Sexual abuse and psychiatric disorder in England: Results from the 2007 Adult Psychiatric Morbidity Survey. *Psychological medicine*. 2011; 41:709–719. [PubMed: 20534178]
- Kessler RC, Berglund Patricia A, Demler Olga, Jin Robert, Koretz D, Merikangas Kathleen R, et al. Wang Philip S. The Epidemiology of Major Depressive Disorder: Results from the National Comorbidity Survey Replication (NCS-R). *Journal of the American Medical Association*. 2003; 289(23):3095–3105. [PubMed: 12813115]

- Kessler RC, McLaughlin KA, Green JG, Gruber MJ, Sampson NA, Zaslavsky Alan M, et al. Williams DR. Childhood adversities and adult psychopathology in the WHO World Mental Health Surveys. *British Journal of Psychiatry*. 2010; 197:378–385. [PubMed: 21037215]
- Kessler RC, Sonnega A, Evelyn B, Hughes M, Nelson CB. Posttraumatic stress disorder in the National Comorbidity Survey. *Archives of General Psychiatry*. 1995; 52:1048–1060. [PubMed: 7492257]
- Koenen KC, Widom CS. A prospective study of sex differences in the lifetime risk of posttraumatic disorder among abused and neglected children grown up. *Journal of Traumatic Stress*. 2009; 22(6): 566–574. [PubMed: 19937646]
- Kubzansky LD, Bordoelois P, Jun HJ, Roberts AL, Cerda M, Bluestone N, Koenen KC. The Weight of Traumatic Stress: A Prospective Study of Posttraumatic Stress Disorder Symptoms and Weight Status in Women. *JAMA Psychiatry*. 2013
- MacMillan HL, Tanaka M, Duku EK, Vaillancourt T, Boyle MH. Child physical and sexual abuse in a community sample of young adults: results from the Ontario Child Health Study. *Child Abuse & Neglect*. 2013; 37(1):14–21. [PubMed: 23290623]
- Mamun AA, Lawlor DA, O'Callaghan MJ, Bor W, Williams GM, Najman JM. Does childhood sexual abuse predict young adult's BMI? A birth cohort study. *Obesity*. 2007; 15(8):2103–2110. [PubMed: 17712129]
- McCutcheon VV, Heath AC, Nelson EC, Bucholz KK, Madden PA, Martin NG. Clustering of Trauma and Associations with Single and co-Occurring Depression and Panic Attack over Twenty Years. *Twin Research and Human Genetics*. 2010; 13(1):57–65. [PubMed: 20158307]
- Molnar BE, Buka SL, Kessler Ronald C. Child sexual abuse and subsequent psychopathology: Results from the National Comorbidity Survey. *American Journal of Public Health*. 2001; 91(5):753–760. [PubMed: 11344883]
- Noll JG, Zeller MH, Trickett PK, Putnam FW. Obesity risk for female victims of childhood sexual abuse: A prospective study. *Pediatrics*. 2007; 120(1):e61–e67. [PubMed: 17606550]
- Ogden, CL.; Carroll, MD.; Kit, BK.; Flegal, KM. Prevalence of obesity in the United States, 2009–2010. Hyattsville, MD: National Center for Health Statistics; 2012.
- Perkonig A, Owashi T, Stein MB, Kirschbaum C, Wittchen HU. Posttraumatic Stress Disorder and Obesity: Evidence for a Risk Association. *American Journal of Preventive Medicine*. 2009; 36(1): 1–8. [PubMed: 18976880]
- Pine DS, Goldstein RB, Wolk S, Weissman MM. The association between childhood depression and adulthood body mass index. *Pediatrics*. 2001; 107(5):1049–1056. [PubMed: 11331685]
- Rao JNK, Scott AJ. On chi-squared tests for multiway contingency tables with cell proportions estimated from survey data. *Annals of Statistics*. 1984; 12(1):46–60.
- Rayworth BB, Wise LA, Harlow BL. Childhood abuse and risk of eating disorders in women. *Epidemiology*. 2004; 15(3):271–278. [PubMed: 15097006]
- Roeholt S, Beck NN, Karsberg SH, Elklit A. Post-traumatic stress symptoms and childhood abuse categories in a national representative sample from a specific age group: Associations to body mass index. *European Journal of Psychotraumatology*. 2012; 3
- Rohde P, Ichikawa L, Simon GE, Ludman EJ, Linde JA, Jeffery RW, Operskalski BH. Associations of child sexual and physical abuse with obesity and depression in middle-aged women. *Child Abuse Negl*. 2008; 32(9):878–887. [PubMed: 18945487]
- Scott KM, McGee MA, Wells JE, Oakley Browne MA. Obesity and mental disorders in the adult general population. *Journal of Psychosomatic Research*. 2008; 64(1):97–105. [PubMed: 18158005]
- Sedlak, AJ.; Mettenberg, J.; Basena, M.; Petta, I.; McPherson, K.; Green, A.; Li, S. Fourth National Incidence Study of Child Abuse and Neglect (NIS-4): Report to Congress. Washington, D.C: 2010.
- Shin SH, Miller DP. A longitudinal examination of childhood maltreatment and adolescent obesity: Results from the National Longitudinal Study of Adolescent Health (AddHealth) Study. *Child Abuse & Neglect*. 2012; 36:84–94. [PubMed: 22398304]
- StataCorp. Stata Statistical Software: Release. Vol. 9. College Station TX: StataCorp LP; 2005.

- Sugaya L, Hasin DS, Olfson Mark, Lin KH, Grant Bridget F, Blanco C. Child physical abuse and adult mental health: A national study. *Journal of Traumatic Stress*. 2012; 25:384–392. [PubMed: 22806701]
- U.S. Department of Health and Human Services, Administration for Children and Families, Administration on Children, Youth and Families, Children's Bureau. *Child maltreatment 2012*. 2012. Available from <http://www.acf.hhs.gov/programs/cb/research-data-technology/statistics-research/child-maltreatment>
- Veldwijk J, Proper KI, Hoeven-Mulder HB, Bemelmans WJE. The prevalence of physical, sexual and mental abuse among adolescents and the association with BMI status. *BMC Public Health*. 2012; 12:840. [PubMed: 23033819]
- Waldron M, Bucholz KK, Lynskey MT, Madden PAF, Heath AC. Alcoholism and Timing of Separation in Parents: Findings in a Midwestern Birth Cohort. *Journal of Studies on Alcohol and Drugs*. 2013; 74:377–348.
- Waldron M, Madden PA, Nelson CB, Knopik Valerie S, Glowinski A, Grant JD, et al. Heath AC. The interpretability of family history reports of alcoholism in general community samples: findings in a Midwestern US twin birth cohort. *Alcoholism: Clinical and Experimental Research*. 2012; 36(6): 1091–1098.
- Widom CS, Raphael KG, DuMont K. The case for prospective longitudinal studies in child maltreatment research: Commentary on Dube, Williamson, Thompson, Felitti, and Anda (2004). *Child Abuse & Neglect*. 2004; 28:715–722. [PubMed: 15261466]
- Widom CS, Weiler BL, Cottler Linda B. Childhood victimization and drug abuse: a comparison of prospective and retrospective findings. *Journal of Consulting & Clinical Psychology*. 1999; 67(6): 867–880. [PubMed: 10596509]
- Wiederman MW, Sansone Randy A, Sansone LA. Obesity among sexually abused women: An adaptive function for some? *Women and Health*. 2008; 29(1):89–100. [PubMed: 10427643]
- Williamson DF, Thompson TJ, Anda RF, Dietz WH, Felitti V. Body weight and obesity in adults and self-reported abuse in childhood. *Int J Obes Relat Metab Disord*. 2002; 26(8):1075–1082. [PubMed: 12119573]

Table 1
Items used to assess childhood physical abuse, sexual abuse, and neglect shown by section of the interview

Physical Abuse	Wave of data collection
<i>Parental Discipline and Early Childhood Experiences</i>	
When you were 6 to 13...	
When you did something wrong, how often were you hit with a belt or stick or something like that by your mother figure/father figure? ^a	1, 3, 4
What was the usual way in which your parents punished or disciplined you?	1, 3
Physical harsh (e.g., use weapon, kick)	
How often did your mother figure/father figure punish you so hard that you hurt the next day? ^a	4
Were you ever physically injured or hurt on purpose by an adult (e.g., having broken bones or burns)? ^b	1, 3, 4
<i>Traumatic Events</i>	
Did event #7 ever happen to you: you were physically abused as a child (a relative or another adult harmed you causing you to have bruises, cuts, or broken bones, or need medical treatment, miss school, or hurt the following day)? ^b	1, 3, 4
Neglect	
<i>Parental Discipline and Early Childhood Experiences</i>	
When you were 6 to 13...	1, 3
What was the usual way in which your parents punished or disciplined you?	
Non-physical harsh (e.g., lock in closet, deprive of food)	
<i>Traumatic Events</i>	
Did event #8 ever happen to you: you were seriously neglected as a child (you were not given adequate food, clothing, shelter, emotional support, or medical care, or your education or safety was not adequately supervised)?	1, 3, 4
Sexual abuse	
<i>Traumatic Events</i>	
Did event #4 ever happen to you: you were raped (someone had sexual intercourse with you when you did not want to, by threatening you or using some degree of force)? ^b	1, 3, 4
Did event #5 ever happen to you: you were sexually molested (someone touched or felt your genitals when you did not want them to, or forced you to touch his or her genitals)? ^b	1, 3, 4
<i>Health Problems and Health Habits</i>	
Has anyone ever forced you to have sexual intercourse? ^b	1, 3, 4
<i>Parental Discipline and Early Childhood Experiences</i>	
Before you turned 16 years old, was there any forced sexual contact with between you and <u>any</u> family member like a parent or step-parent, grandparent, uncle, aunt, brother, sister or cousin? By sexual contact I mean their touching your sexual parts, your touching their sexual parts, or sexual intercourse.	4
Before you turned 16 years old, was there any sexual contact between you and anyone who was 5 or more years older than you were (<u>other than a family member</u>)? (By sexual contact I mean their touching your sexual parts, your touching their sexual parts, or sexual intercourse.) If yes: Was this sexual contact (always) with your consent or were you (ever) forced? ^c	4

^a positive if frequency reported as 'often';

^b positive if occurred before age 16;

^c positive if not (always) consensual

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Sample characteristics among 3699 young adult women by BMI category. All numbers are percentages unless otherwise noted

Table 2

	Underweight n=240	Normal Weight n=2295	Overweight n=667	Obese n=497	p-value
African-American	2.50	9.37	22.79	29.38	<.001
Age greater than 22 years	27.08	35.08	43.78	53.92	<.001
Married or cohabiting	30.83	29.24	35.68	39.39	<.001
Menarche before age 12 years	8.40	16.23	26.84	23.86	<.001
Pregnant or post-partum					<.001
Yes	1.67	4.92	11.84	10.46	
No	78.75	82.79	75.56	76.86	
Missing	19.58	12.29	12.59	12.68	
Maternal education *					<.001
Less than high school	8.75	7.63	13.19	21.53	
High school or greater	89.17	90.15	84.71	75.25	
Missing	2.08	2.22	2.10	3.22	
Paternal education *					<.001
Less than high school	12.08	8.24	12.29	17.51	
High school or greater	85.42	88.28	83.51	75.45	
Missing	2.50	3.49	4.20	7.04	
Parental separation before age 18 years	37.50	39.26	47.15	51.01	<.001
Maternal alcoholism **					.031
Yes	3.75	5.62	6.45	7.24	
Probable	6.25	4.27	3.45	7.65	
No	90.00	90.10	90.10	85.11	
Paternal alcoholism **					.001
Yes	16.67	19.0	20.85	20.85	
Probable	17.75	9.13	10.57	18.02	
No	65.83	71.79	68.58	61.13	
Other traumatic events before age 16					
Natural disaster	12.71	12.43	11.11	15.38	.228
Life threatening accident	5.83	4.85	6.00	6.85	.280

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	Underweight n=240	Normal Weight n=2295	Overweight n=667	Obese n=497	p-value
Witnessed injury or death	5.83	6.32	10.04	9.88	.002
Physically assaulted	1.67	1.31	2.25	4.23	<.001
Threatened with a weapon	3.75	1.96	2.25	4.84	.003

Note:

* self-, coparent- or twin-report;

** yes = self-report or positive report from 2 or more informants, probable = positive report from one informant; all numbers are percentages unless otherwise noted.

Prevalence of child abuse and neglect and post-traumatic stress disorder among 3699 young adult women by BMI category

Table 3

	Underweight n=240	Normal Weight n=2295	Overweight n=667	Obese n=497	p-value
Sexual abuse	13.75	9.02	14.69	25.35	<.001
Physical abuse	17.92	16.95	25.64	31.19	<.001
Neglect	4.17	1.83	3.60	6.04	<.001
Number of maltreatment forms reported					<.001
0	71.67	77.78	66.57	57.34	
1	22.92	17.17	24.14	26.56	
2	3.33	4.53	8.19	12.27	
3	2.08	0.52	1.20	3.82	
Post-traumatic Stress Disorder	4.17	2.57	5.85	7.44	<.001

Table 4
Odds ratios from multinomial logistic regression models for underweight, overweight or obese women relative to normal weight women for forms of child maltreatment

	Underweight <i>OR (95% CI)</i>	Overweight <i>OR (95% CI)</i>	Obese <i>OR (95% CI)</i>
Sexual abuse			
1. Unadjusted	1.61 (1.06, 2.44)	1.74 (1.33, 2.27)	3.73 (2.63, 4.47)
1. Adjusted for other maltreatment forms	1.53 (0.98, 2.39)	1.48 (1.11, 1.97)	2.75 (2.07, 3.65)
2. Adjusted for other maltreatment forms and covariates	1.47 (0.93, 2.32)	1.34 (0.99, 1.82)	2.20 (1.62, 2.98)
3. Adjusted for other maltreatment forms, covariates and PTSD	1.43 (0.90, 2.28)	1.24 (0.90, 1.71)	2.12 (1.55, 2.89)
Physical abuse			
1. Unadjusted	1.07 (0.75-1.53)	1.69 (1.36-2.09)	2.22 (1.74, 2.83)
2. Adjusted for other maltreatment forms	0.91 (0.63, 1.33)	1.52 (1.21, 1.91)	1.75 (1.27, 2.14)
3. Adjusted for other maltreatment forms and covariates	1.04 (0.69, 1.58)	1.19 (0.93, 1.53)	1.18 (0.89, 1.57)
4. Adjusted for other maltreatment forms, covariates and PTSD	1.04 (0.68, 1.57)	1.17 (0.91, 1.50)	1.17 (0.88, 1.56)
Neglect			
1. Unadjusted	2.33 (1.08, 5.05)	2.00 (1.19, 3.37)	3.45 (2.06, 5.77)
2. Adjusted for other maltreatment forms	2.10 (0.96, 4.57)	1.40 (0.81, 2.42)	1.78 (1.03, 3.06)
3. Adjusted for other maltreatment forms and covariates	2.16 (0.90, 5.16)	1.13 (0.63, 2.02)	1.05 (0.56, 1.96)
4. Adjusted for other maltreatment forms, covariates and PTSD	2.14 (0.91, 5.03)	1.11 (0.62, 1.98)	1.14 (0.55, 1.94)