



Is the childhood home food environment a confounder of the association between child maltreatment exposure and adult body mass index?



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ARTICLE INFO

Keywords:

Child maltreatment
Obesity
Confounding

ABSTRACT

Childhood maltreatment is consistently associated with adult obesity, leading to calls for tailored weight interventions for people with maltreatment histories. However, it is possible that the maltreatment–obesity association is spurious and driven by unmeasured confounding, in which case such interventions would be misplaced. The home food environment in childhood is a potential confounder, but its role in the association of maltreatment with obesity has not been examined. We used a longitudinal dataset (Project EAT) to examine the association of adult retrospective reports of maltreatment history in childhood (1+ types of maltreatment before age 18 years) with previously-collected prospective childhood reports of home food environment characteristics (availability of healthy foods, availability of sweet/salty snack food, family meal frequency, and food insufficiency). We then estimated the association between maltreatment and adult body mass index (BMI, kg/m²) with and without adjustment for these home food environment factors. After adjustment for sociodemographics, maltreatment had a 0.84 kg/m² (95% CI: 0.28, 1.41) higher BMI at age 24–39 years, compared to those with no maltreatment, after adjustment for sociodemographics, parenting style, and BMI in childhood. Additional adjustment for home food environment factors had little effect on this association ($\beta = 0.78$ kg/m²; 95% CI: 0.21, 1.35), suggesting limited confounding influence of the home food environment factors. Findings provide additional robust evidence that childhood maltreatment is a risk factor for obesity that may warrant tailored interventions.

1. Introduction

Childhood maltreatment, including abuse and neglect by adult caregivers, is highly prevalent (Tjaden and Thoennes, 2000; Finkelhor et al., 2015) and has been consistently found to predict obesity (Danese and Tan, 2013; Schneiderman et al., 2012; Shin and Miller, 2012; Mason et al., 2015a; Noll et al., 2007; Williamson et al., 2002; Alvarez et al., 2007; Mamun et al., 2007; Fuller-Thomson et al., 2013; Hemingsson et al., 2014; Midei et al., 2010) and obesity-related disease (Riley et al., 2010; Rich-Edwards et al., 2010; Rich-Edwards et al., 2012; Mason et al., 2016). Evidence for the causality of the maltreatment–obesity relationship includes prospective evidence documenting the temporal order from maltreatment to weight change (Noll et al., 2007), and animal, clinical, and epidemiologic research identifying several plausible maltreatment–obesity mechanisms (Tomiyama et al., 2011; Ulrich-Lai et al., 2010; Corwin et al., 2011; Greenfield and Marks, 2009; Hirth et al., 2011; Mason et al., 2014). This research suggests a need for targeted obesity prevention for those with

maltreatment histories (Mason et al., 2015b). However, given the necessary reliance on observational data, the possibility that maltreatment–obesity associations are spurious and driven by confounding remains a concern. Although childhood maltreatment is an urgent public health issue regardless of its impact on obesity, determining whether its association with adult obesity is causal is crucial for deciding whether people with maltreatment histories should be offered obesity-specific interventions. Therefore, identifying confounders of the maltreatment–obesity relationship is critical for advancing the field.

Prior investigations of maltreatment and obesity have adjusted for a range of factors including demographics (race/ethnicity, age, gender) and socioeconomic status (Danese and Tan, 2013). However, one set of potentially important confounders that previous child maltreatment–obesity research has not accounted for is childhood home food environments that may track with maltreatment and contribute to obesity risk. Food environments characterized by limited fresh fruits and vegetables, plentiful sweet and salty snack food, food insufficiency, and infrequent family meals have been found to be associated with poor

Abbreviations: RR, Risk ratio; CI, Confidence interval

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<https://doi.org/10.1016/j.ypmed.2018.02.016>

Received 26 July 2017; Received in revised form 5 January 2018; Accepted 12 February 2018

Available online 14 February 2018

0091-7435/ © 2018 Published by Elsevier Inc.

dietary intake and/or obesity (Martin-Biggers et al., 2014; Berge et al., 2015; Widome et al., 2009; Campbell et al., 2007). These food environments may be correlated with childhood maltreatment, either through shared socioeconomic contexts (Neumark-Sztainer et al., 2003; Drake and Zuravin, 1998), or due to family dynamics that influence both home food environments and risk for maltreatment (Berge et al., 2010a; Rodriguez, 2010). For example, socioeconomic disadvantage is associated with both maltreatment risk (Pelton, 2015) and more processed and fewer fresh foods in the home (Ranjit et al., 2015). Although prior studies have adjusted for socioeconomic status, this adjustment alone may not fully account for home food environments, leaving residual confounding. To the best of our knowledge, there is no research examining the associations between childhood maltreatment and home food environments, nor is it known what role home food environments play in the maltreatment–obesity association.

To address this gap, we use data from the longitudinal Project EAT cohort, which is unique in having both childhood maltreatment data and measures of home food environments assessed in childhood. Our aims were to: (1) identify childhood home food environment factors that are correlated with childhood maltreatment, and (2) assess the impact of adjusting for these factors on the association between child maltreatment and adult weight.

2. Methods

2.1. Study design

Analyses were conducted in Project EAT (Eating and Activity in Teens and Young Adults), a longitudinal study of weight-related health among young people. Project EAT-I (baseline) included 4746 middle school and high school adolescents (mean age 15.0 years) from Minneapolis/St. Paul who completed surveys and anthropometric measures in 1998–1999. Participants were followed via survey every 5 years. The fourth wave survey (Project EAT-IV) was administered in 2015–2016 (mean age 31.1 years) to participants who had responded to at least two prior surveys, and for whom correct contact information was available ($N = 2770$). EAT-IV included questions about exposure to maltreatment in childhood (prior to age 18 years). Of contacted participants, 66.1% completed the EAT-IV survey ($n = 1830$). We excluded participants missing maltreatment information ($n = 26$), BMI at EAT-IV ($n = 20$), one or more home food environment variables of interest ($n = 94$), and/or one or more covariates ($n = 208$), leaving 1547 for our analytic sample. Compared to the original sample, our analytic sample was similar in mean age at baseline (15.0 years versus 14.9 years), but had a higher proportion of female participants (55.8% versus 49.7%) and participants with one or more college-educated parents (52.6% versus 37.2%), and a lower proportion of non-white participants (27.6% versus 51.5%). All models were weighted to adjust for differential non-response to the EAT-IV survey across socio-demographic groups.

At EAT-IV, the analytic sample had a mean age of 31.1 years ($SD = 1.6$) and was 72.4% white, 13.6% Asian, 6.5% African American, 3.2% Hispanic, and 4.3% mixed or other. All study protocols were approved by the University of Minnesota's Institutional Review Board Human Subjects Committee.

2.2. Measures

The analysis consisted of two stages. In the first stage, we examined the association between maltreatment and home food environments in childhood. In the second stage, we examined the association between child maltreatment and adult body weight, with and without adjustment for home food environments. Test-retest reliabilities for EAT-I, on which home food environments were measured, were determined in a pilot sample of adolescents selected to be demographically representative of the study population ($n = 161$) (Neumark-Sztainer

et al., 2002). For the EAT-IV survey, on which maltreatment was measured, reliability was measured in a subgroup of EAT-IV participants invited to take the survey twice; every third EAT-IV respondent to the survey was invited until adequate sample was achieved ($n = 103$).

2.2.1. Childhood maltreatment

Our main independent variable for both stages of analysis was maltreatment by a family member during childhood (< 18 years), defined based on 4 EAT-IV questions assessing physical, emotional, and sexual abuse, and emotional neglect. Participants were asked to report the frequency (5-point scale from “never” to “very often”) that “an adult in my family hit me so hard it left bruises or marks” (physical abuse), “an adult in my family said hurtful or insulting things to me” (emotional abuse), and “my family was a source of strength and support” (emotional neglect). Sexual abuse was assessed with the question, “did someone in your family touch you in a sexual way against your wishes or force you to touch them in a sexual way?” (response options were “no”, “once”, “more than once”). Test-retest values ranged from 0.70 (emotional abuse) to 0.90 (sexual abuse).

We defined participants as exposed to each type of maltreatment using the following definitions, informed by the Adverse Childhood Experiences (ACE) Scale (Felitti et al., 1998; Dube et al., 2003). *Physical abuse* was defined as ever being hit by a family member so hard that it left bruises or marks. *Sexual abuse* was defined as one or more experiences of unwanted sexual touching. *Emotional abuse* was defined as an adult in the family saying hurtful or insulting things “often” or “very often.” *Emotional neglect* was defined when participants indicated that their family was a source of strength and support “never” or “rarely”. To calculate an overall maltreatment score similar to the ACE scale, we initially summed the number of maltreatment experiences; however, preliminary analyses indicated that there were few meaningful differences in prevalence of home environment variables or average BMI between those exposed to 1 type of maltreatment and those exposed to 2 or more types. Thus, we present analyses of maltreatment dichotomized as any versus none.

2.2.2. Childhood home environment factors

We examined maltreatment associations with the following 4 characteristics of the home environment measured at EAT-1 (ages 11–18 years), which have been found to be associated with obesity-promoting behaviors and weight status (Martin-Biggers et al., 2014; Berge et al., 2015; Widome et al., 2009; Campbell et al., 2007): (1) availability of healthy foods (fruits, vegetables, milk); (2) availability of sweets and salty snack foods; (3) food insufficiency; and (4) frequency of family meals.

2.2.2.1. Availability of healthy foods. Participants were asked how often in their home (‘never’, ‘sometimes’, ‘usually’, ‘always’): (1) fruits and vegetables were available, (2) vegetables were served at dinner, and (3) milk was served at meals. Test-retest values for individual items ranged from $r = 0.55$ to 0.59 . Responses for each item were dichotomized into ‘usually’ or ‘always’ versus ‘never’ or ‘sometimes’ and summed these into a score ranging from 0 (none of the 3 food availability measures were usually or always true) to 3 (all 3 food availability measures were usually or always true). In the first stage of our analysis, where we investigate the association of maltreatment with availability of healthy foods, we further dichotomized this score at 2 for interpretability (i.e., at least 2 of the 3 food availability measures were usually or always true). In our analyses of maltreatment and adult BMI, in which food availability was a covariate, we used the ordinal score.

2.2.2.2. Availability of sweets and salty snack foods. Participants were asked how often in their home (‘never’, ‘sometimes’, ‘usually’, ‘always’): (1) potato chips and other salty snack foods were available, (2) chocolate or other candy was available, and (3) soda pop was available. Test-retest was assessed for soda pop only ($r = 0.72$). As

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