



## Using path analysis to examine the relationship between sexual abuse in childhood and diabetes in adulthood in a sample of US adults

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### ABSTRACT

To understand mechanisms underlying the relationship between adverse childhood experiences (ACE) and diabetes the study evaluated mediators of the relationship between childhood sexual abuse and diabetes in adulthood. This study used cross-sectional data from the 2011 Behavioral Risk Factor Surveillance Survey (BRFSS). Participants totaled 48,526 who completed the ACE module. Based on theoretical relationships, path analysis was used to investigate depression and obesity as pathways between childhood sexual abuse, and diabetes in adulthood.

Among adults with diabetes, 11.6% experienced sexual abuse. In the unadjusted model without mediation, sexual abuse was significantly associated with depression (OR = 4.48, CI 4.18–4.81), obesity (OR = 1.28, CI 1.19–1.38), and diabetes (OR = 1.39, CI 1.25–1.53). In the unadjusted model with mediation, depression and obesity were significantly associated with diabetes (OR = 1.59, CI 1.48–1.72, and OR = 3.77, CI 3.45–4.11, respectively), and sexual abuse and diabetes was no longer significant (OR = 1.10, CI 0.98–1.23), suggesting full mediation. After adjusting for covariates in the mediation model, significance remained between sexual abuse and depression (OR = 3.04, CI 2.80–3.29); sexual abuse and obesity (OR = 1.41, CI 1.29–1.53), depression and diabetes (OR = 1.35, CI 1.23–1.47); and obesity and diabetes (OR = 3.53, CI 3.20–3.90). The relationship between sexual abuse and diabetes remained insignificant (OR = 1.09, CI 0.96–1.24).

This study demonstrates that depression and obesity are significant pathways through which childhood sexual abuse may be linked to diabetes in adulthood. These results can guide intervention development, including multifaceted approaches to treat depression and increase physical activity in patients with a history of sexual abuse to prevent diabetes.

According to the Centers for Disease Control and Prevention (CDC), childhood maltreatment occurred in 3.4 million children in 2012 and it is estimated that every year, 1 in 4 children will experience some form of maltreatment in the United States (Felitti et al., 1998). Childhood maltreatment is of significant public health concern as research shows that the consequences span through adulthood and include impaired cognitive development, risky health behaviors, greater disease burden, and early mortality (Felitti et al., 1998; Center for Disease Control and Prevention (CDC), 2016). Broadly defined, adverse childhood experiences (ACEs) are stressful events occurring throughout the developmental stages of a child's life that can have traumatic effects and impact on health and behavior in adulthood. These include four domains of abuse including psychological, physical, sexual, and household dysfunction (Center for Disease Control and Prevention (CDC), 2016).

Recent examination of the impact of ACEs on adult health has shown that individuals who experience ACEs are at greater risk for the development of chronic diseases in adulthood, including diabetes (Center for Disease Control and Prevention (CDC), 2016; Huang et al., 2015; Monnat and Chandler, 2015; Shields et al., 2016). The relationship between ACEs and diabetes has been found to be graded and the literature suggests that specific ACEs as well as variations in intensity of ACEs experienced may have more impact on the development of diabetes than others (Monnat and Chandler, 2015; Shields et al., 2016; Felitti, 2009; Friedman et al., 2015). Diabetes is an important public health concern, affecting > 29 million people or 9.3% of the total U.S. population, and is the seventh leading cause of death in the U.S (Centers for Disease Control and Prevention (CDC), 2017). Medical expenditures among those diagnosed with diabetes are twice the

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expenditures of those without, with primary expenditures arising from inpatient hospital stays as well as cost of prescriptions (Ozieh et al., 2015). In 2012, the overall direct and indirect cost of diabetes in the U.S. was \$245 billion (Centers for Disease Control and Prevention (CDC), 2017). Current trends predict that as many as 1 in 3 Americans will have diabetes by the year 2050 (Boyle et al., 2010).

The literature has shown that of the various ACE categories, childhood sexual abuse, in particular, is strongly linked to the development of diabetes in adulthood in both men and women, compared to other chronic illness (Shields et al., 2016; Campbell et al., 2016; Rich-Edwards et al., 2010). For instance, Shields et al. (Shields et al., 2016) found that experiencing sexual abuse was related to 1.5 to 2 fold increase of developing diabetes in adulthood, with increased risk being associated with intensity of sexual abuse reported. Additionally, Campbell et al. (Campbell et al., 2016) found that individuals who experienced sexual abuse were 45% more likely to develop diabetes in adulthood compared to 14% and 18% for coronary heart disease and stroke, respectively (Campbell et al., 2016). The hypothesized mechanisms underlying this relationship between ACEs, such as sexual abuse, and diabetes include both physiological and psychosocial pathways (Shonkoff et al., 2012; Bertone-Johnson et al., 2012; Coelho et al., 2014). The physiological pathway is hypothesized to occur via chronic stress that leads to inflammatory and metabolic alteration, ultimately disrupting metabolic function (Bertone-Johnson et al., 2012; Coelho et al., 2014; Davis et al., 2014a; Davis et al., 2014b). The psychosocial pathway is thought to occur via accumulated risk factors for poor health behaviors that impact overall health outcomes over time (Bertone-Johnson et al., 2012; Coelho et al., 2014; Davis et al., 2014a; Davis et al., 2014b). However, the design for the studies testing these proposed mechanisms have various limitations. For example, studies examining alteration of inflammatory responses have been limited by differential processes for defining and classifying exposure (Coelho et al., 2014). Similarly, studies evaluating the psychosocial pathway have been restricted by small sample size and lack of standardization in measures (Davis et al., 2014b).

While the literature has examined the association that overall ACEs have with the development of diabetes, greater understanding about the potential mediators of the relationship is needed to develop more targeted public health interventions. In order to address this gap in knowledge, this study evaluates the mediators of the relationship between sexual abuse in childhood and self-reported diabetes in adulthood using path analysis and theory based models to test for mediation. Sexual abuse was selected from the ACE categories for independent path analysis based on suggestions of the literature as being a significant predictor of diabetes in adulthood in comparison to other ACE categories (Shields et al., 2016; Campbell et al., 2016; Duncan et al., 2015; Rich-Edwards et al., 2010). Using national data from the 2011 Behavioral Risk Factor Surveillance System (BRFSS), this study helps elucidate potential pathways through which sexual abuse in childhood and diabetes in adulthood are associated.

## 1. Research design and methods

### 1.1. Sample

This study used data from the 2011 Behavioral Risk Factor Surveillance System (BRFSS) survey, a cross-sectional telephone survey organized by the CDC. Participants include non-institutionalized adults 18 years and older in the United States. Data collection is conducted by state health departments using random-digit dialing to landline and cellular telephones (Centers for Disease Control and Prevention (CDC), 2013). Nationally representative estimates are achieved through a complex sampling design using data weighting in analysis (Centers for Disease Control and Prevention (CDC), 2013). The CDC, in collaboration with public health departments, develops standardized questionnaires in each state and includes a standard core, optional modules,

and state-added questions (Centers for Disease Control and Prevention (CDC), 2013). Participants completing the 2011 BRFSS survey totaled 506,467, with 48,526 participants completing the ACE module across five states. This study sample only included data from the five states that administered the ACE module: Minnesota, Montana, Vermont, Washington and Wisconsin. The current study was exempt from Institutional Review Board (IRB) review since it was a secondary analysis of publicly available data.

### 1.2. Measures

#### 1.2.1. Adverse childhood experiences (ACE)

An 11-item survey where respondents are asked if they ever experienced sexual, physical, or verbal abuse, or family dysfunction during their childhood (prior to 18 years of age) (Centers for Disease Control and Prevention (CDC), 2013). In this study, we focused on responses to the three questions specific to sexual abuse. Respondents noted frequency of experiencing anyone at least 5 years older, or an adult, ever forcing sex; forcing touching; or if respondent was ever forced to touch sexually. As this analysis focused primarily on pathways using a logit model, positive response to any frequency on any of the three questions was coded as a yes (vs. no) on a dichotomous variable to assess sexual abuse. Dichotomizing this variable is a valid method seen elsewhere (Campbell et al., 2016; Cunningham et al., 2014; Dong et al., 2004).

#### 1.2.2. Diabetes

Diabetes was self-reported, using the question: Has a doctor or other healthcare provider ever told you that you have diabetes? Based on prevalence estimates approximately 95% of the diabetes population have type 2 diabetes and only 5% have type 1 diabetes (Centers for Disease Control and Prevention (CDC), 2017). As such, this variable is used as an estimate of U.S. adults assumed to indicate type 2 diabetes (Mokdad et al., 2003).

#### 1.2.3. Depression

Depression was a self-report measure using the question: Has a doctor or other healthcare provider ever told you that you have a depressive disorder (including depression, major depression, dysthymia, or minor depression)? This variable is a validated measure used in the literature (Newschaffer, 1998).

#### 1.2.4. Overweight/obesity

Overweight/Obesity was assessed based on Body Mass Index (BMI)  $\geq 25$ . The BMI calculated variable from the BRFSS 2011 dataset was used. Calculated variable for BMI in BRFSS is derived from WTKG3 and HTM4. It is calculated by dividing WTKG3 by HTM4<sup>2</sup> as recommended by the CDC (Centers for Disease Control and Prevention (CDC), 2013). This variable is validated measure used in the literature and was categorized as higher than 25 or < 25 using standard calculations based on CDC designation (Mokdad et al., 2003; Centers for Disease Control and Prevention (CDC), 2016).

#### 1.2.5. Demographics

The BRFSS survey collects age, gender, race, marital status, education, employment, region of the United States, and income from all individuals. Age was categorized as 18–34 years, 35–54 years, 55–64 years, and 65 years or greater. Gender was dichotomized. Race/ethnicity was categorized as Non-Hispanic White, Non-Hispanic Black, Hispanic and Non-Hispanic Other. Due to sampling distribution, Native American, Pacific Islander, Asian and other were categorized as Non-Hispanic Other. Marital status was characterized as married, separated/divorced/widowed, and not married. Education was categorized as less than high school education, high school graduate, some college, and college graduate. Employment was categorized as unemployed, employed and retired. Region was categorized as Northeast, Midwest, and

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