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Food insecurity and dyslipidemia in a representative population-based sample in the US

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ABSTRACT

Objective. The association of food insecurity with dyslipidemia has not been firmly established. The main objective of this study was to assess whether food insecurity was associated with dyslipidemia.

Method. A population-based sample of 1,663 adults from the 2008–2011 Survey of the Health of Wisconsin was used. Food insecurity was defined as an affirmative response to either of the questions: (1) "In the last 12 months, have you been concerned about having enough food for you or your family?" (2) "In the last 12 months, have your food choices been limited because there wasn't enough money?" High total cholesterol was defined as total cholesterol (TC) >240 mg/dL or taking prescribed lipid-lowering medication. Low high-density lipoprotein cholesterol (HDL-C) was defined as <40 mg/dL in men and <50 mg/dL in women.

Results. Food insecurity was not associated with high TC either among men or women. Food insecurity was associated with a higher likelihood of low HDL-C among women (adjusted odds ratio [AOR]: 2.31 {95% confidence interval [CI]: 1.42, 3.76}), but not among men. Obesity appears to be a partial mediator of the association among women (P from the Sobel test = 0.01).

Conclusion. These findings suggest that food insecurity may contribute to an increased risk of low HDL-C in women.

Introduction

An estimated 17.6 million (14.5%) of U.S. households experienced food insecurity in 2012 (Coleman-Jensen et al., 2013). This proportion suggests approximately 48.9 million adults struggled to obtain nutritionally adequate and safe foods due to a lack of sufficient resources at some time during 2012 (Coleman-Jensen et al., 2013). In a recent analysis, we estimated that more than 740,000 adults are suffering from food insecurity in Wisconsin (Guerrero et al., 2014).

Food insecurity is the perceived state of lack of food and food availability measured over a certain period of time. A lack of access to food is often associated not only with dietary quantity (i.e., food shortages due to insufficient food availability) but also dietary quality (e.g., lower intake of fruits and vegetables) (Laraia, 2013). Restricted dietary options, a number of coping strategies of dietary behavior to overcome hunger and/or energy deficiency, and subsequent stress among individuals experiencing food insecurity may lead to changes in physical status, poor nutrition, and development of chronic disease (Laraia, 2013).

Previous studies suggest that food insecurity is associated with adverse health outcomes in adults, including poor general health status (Stuff et al., 2004; Vozoris and Tarasuk, 2003), type 2 diabetes mellitus (Seligman et al., 2007, 2010; Vozoris and Tarasuk, 2003), hypertension (Seligman et al., 2010; Vozoris and Tarasuk, 2003), and cardiovascular disease (Vozoris and Tarasuk, 2003). Also, a paradoxical relationship between food insecurity and increased obesity has been observed in the U.S. adult population, especially among women (Dinour et al., 2007; Gooding et al., 2012; Holben and Pheley, 2006; Laraia et al., 2010; Townsend et al., 2001). It has been hypothesized that food insecurity predisposes individuals to chronic disease by inducing unhealthy dietary behaviors, such as reducing dietary variety and giving preference to a few low-cost, energy-dense, and nutritionally poor foods (Seligman and Schillinger, 2010). Furthermore, fluctuations in the availability of food over time have been associated with psychological stress (Polivy, 1996), which induces metabolic changes that promote fat storage (Adam and Epel, 2007; Torres and Nowson, 2007).

Dyslipidemia, i.e., abnormal serum lipid levels, is a major modifiable risk factor for cardiovascular disease (Fodor, 2010), the leading cause of death and disability in the U.S. (American Heart Association, 2013). Currently, more than half of the U.S. adult population (53%) has dyslipidemia: 13.4% have high total cholesterol (TC), 26.9% have high low-density lipoprotein cholesterol (LDL-C), and 23.3% have low high-density lipoprotein cholesterol (HDL-C) (Tóth et al., 2012). Typically,

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obesity-related dyslipidemia is characterized by high triglycerides, low HDL-C, and normal or slightly high LDL-C (Klop et al., 2013).

Although food insecurity is associated with increased obesity, a known risk factor for dyslipidemia, previous studies on the associations between food insecurity and dyslipidemia have shown inconsistent results (Dixon et al., 2001; Seligman et al., 2010; Tayie and Zizza, 2009). The purpose of this study was to assess the association between a recent history of food insecurity and dyslipidemia in a representative sample of Wisconsin adults.

Methods

We used the combined Survey of the Health of the Wisconsin (SHOW) samples from 2008 to 2011. The SHOW is a cross-sectional sample of the Wisconsin adult population. It consists of a series of independent annual representative surveys (Nieto et al., 2010). Two-stage, probability-based cluster sampling is used to select households and recruit non-institutionalized/non-active duty adult residents ages 21–74 years (Nieto et al., 2010). In each one-year cycle, approximately 400–1,000 adult participants are recruited and are administered an in-home interview (Time 1), a self-administered questionnaire (Time 2), and a clinic visit in a mobile or fixed center that includes a physical exam, laboratory tests, and additional interviews (Time 3). Both SHOW and this study were approved by the University of Wisconsin-Madison Health Sciences Institutional Review Board (IRB). Informed consent was obtained from all study participants.

Data on the main exposure, a recent food security history, was collected using audio computer-assisted self-administered interviews (ACASI) at Time 3. Two questions were included in defining food insecurity as a construct related to both the self-perceived stress about food and access.

- "In the last 12 months, have you been concerned about having enough food for you or your family?"
- "In the last 12 months, have your food choices been limited because there wasn't enough money?"

The first question is from the Social Context Module in the Behavioral Risk Factor Surveillance System (BRFSS) that is used to estimate the prevalence of food insecurity in many states (Centers for Disease Control and Prevention, 2000). The second question is slightly modified from the National Health and Nutrition Examination Survey (NHANES) food security module to assess whether quality and/or quantity of food is limited due to financial constraints (NHANES, 2008). Individuals who answered "yes" to either of these two questions were classified as "having a recent history of food insecurity." We validated the use of these measures amongst a subset of SHOW participants who additionally completed the United States Department of Agriculture (USDA) Adult Food Security 10-item Survey Module (USDA, 2012).

Serum lipid levels, the main outcome of interest, were measured as part of the SHOW exam (Nieto et al., 2010). Dyslipidemia was defined as high TC or low HDL-C. High TC was defined as a serum TC level of ≥240 mg/dL (National Cholesterol Education Program, 2001) or self-reported use of prescribed lipid-lowering drug. Low HDL-C was defined as a serum HDL-C <40 mg/dL in men and <50 mg/dL in women (National Cholesterol Education Program, 2001). Also, standing body height (to the nearest half centimeter) and weight (to the nearest 100 grams) were measured with the participants wearing light clothing and no shoes. Obesity was defined as a body mass index (BMI) ≥30 kg/m^2 (WHO, 2000). Sociodemographic data (including education, income, and occupation), habits (smoking, alcohol intake, and physical activity), and health insurance access were obtained using standardized interviews. Based on the response to the first question of the Short-Form 12 (SF-12) questionnaire (Ware et al., 1996), self-reported health was dichotomized as "fair or poor" vs. "excellent, very good, or good."

We compared differences in baseline characteristics between participants with and without a recent history of food insecurity using Student's *t*-test for continuous variables and chi-square test for categorical variables. We accounted for the complex survey design by weighting all the strata by the inverse of the probability of selection into SHOW (Korn and Graubard, 1991). We used gender-stratified multivariate weighted logistic regression analyses to assess the association between food insecurity and dyslipidemia (high TC, low HDL-C) while controlling for confounding variables. We conducted separate analyses for high TC and low HDL-C. Covariates in our regression models comprised factors known to be associated with outcomes and/or food insecurity, including age (21–39 years, 40–49 years, 50–59 years, 60–74 years) (Gowda et al., 2012; Wenger, 2004), race/ethnicity (self-reported non-Hispanic white, other) (Frank et al., 2014; Gowda et al., 2012), education (less than high school, high school degree or higher) (Gowda et al., 2012; Mahley et al., 2005; Sun et al., 2014), household income (<$20 K/year, $20 K–$45 K/year, >$45 K/year) (Chichlowska et al., 2008; Gowda et al., 2012; Sun et al., 2014), self-reported physical activity (physically active, physically inactive) (Monda et al., 2009), smoking (current, former, never smoker) (Craig et al., 1989; Gowda et al., 2012), and heavy alcohol intake (yes, no) (Brien et al., 2011).

We postulated that obesity was a partial mediator of the putative association between food insecurity and dyslipidemia. To assess this hypothesis, the independent association between food insecurity and dyslipidemia was quantified in models with and without obesity, and the mediating effect of obesity was estimated as the difference between the effects of a history of food insecurity in both models (Baron and Kenny, 1986). We used both the Sobel test and the bootstrapping approach to test the presence of mediation (Preacher and Hayes, 2008).

We performed sensitivity analyses. First, we used two slightly different definitions of food insecurity. For that purpose, the history of food insecurity was defined based on the participant's affirmative response to each of two questions, respectively (i.e., self-reported concern about food, self-reported limited choices of food). Second, we did sensitivity analyses after excluding individuals who received benefits from food assistance programs. We used Stata/MP13 (Stata Corporation, College Station, Texas, US) for all analyses.

Results

A total of 2,479 individuals participated in SHOW between 2008 and 2011 (survey response rate: 56.0%). We excluded 530 participants because they did not have information on either food security history or serum lipid levels. We excluded another 286 participants because of missing information on covariates. These exclusions resulted in 1,663 study participants with complete data for all of our analyses. Among male participants, those included in our analysis were comparable to those who were excluded with respect to recent history of food insecurity, BMI, and serum lipid levels. Likewise, BMI, TC, and HDL-C levels were comparable among women included and excluded from the analysis. However, women included in this analysis had a slightly lower proportion of a recent history of food insecurity (21% vs. 29%) and high TC (26% vs. 41%) than those who were excluded.

The overall prevalence of a recent history of food insecurity was 22.1% (95% confidence interval [CI]; 19.2–25.3). Compared with participants who had not experienced food insecurity last year, those reporting a recent history of food insecurity included a larger proportion of younger individuals, racial minorities, lower educated, lower income, unemployed, individuals lacking health insurance, self-reporting poor or fair health status, and current smokers (Table 1).

The age-adjusted prevalence of obesity was significantly higher among women who had a recent history of food insecurity than in those who did not (51.9% vs. 34.5%; Table 2), but no significant difference was found among men (39.3% vs. 37.1%; Table 3). The age-adjusted prevalence of high TC did not differ by food security history in either men or women (Tables 2 and 3). On the other hand, the age-adjusted prevalence of low HDL-C was significantly higher in women with compared to those without a recent history of food insecurity (67.4% vs. 46.7%; Table 2), but was similar in both groups of men (57.1% vs. 51.1%; Table 3).

After multivariate adjustment, a recent history of food insecurity was significantly associated with a higher prevalence of obesity among women (OR, 2.09; $P = 0.003$; Table 4, model 1), but not among men (OR, 1.09; $P = 0.73$). The interaction between gender and food insecurity with regard to obesity was statistically significant ($P = 0.04$). A recent history of food insecurity was not associated with high TC in either men (OR, 1.01; $P = 0.96$) or women (OR, 0.62; $P = 0.11$). However, a recent history of food insecurity was associated with a higher likelihood of low HDL-C among women (OR, 2.31; $P = 0.001$), but not among men (OR, 1.14; $P = 0.58$). This interaction was statistically significant ($P = 0.01$).