RESEARCH
Original Research

Associations between Food Security Status and Dietary Inflammatory Potential within Lower-Income Adults from the United States National Health and Nutrition Examination Survey, Cycles 2007 to 2014

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ABSTRACT

Background Evidence suggests both that chronic inflammation mediates the association of food insecurity with adverse health outcomes and that diet may be a significant source of inflammation among food insecure individuals.

Objective To examine whether food security status is associated with dietary inflammatory potential.

Design and participants Cross-sectional data came from the National Health and Nutrition Examination Survey (NHANES), cycles 2007 to 2014 (n=10,630). The analysis sample is representative of noninstitutionalized US adults with an income-to-poverty ratio ≤3.00.

Main outcome Dietary Inflammatory Index (DII) score, calculated using the average of two 24-hour dietary recalls, was the main outcome measure.

Statistical analysis Type III *F* tests or χ^2 tests compared population characteristics by food security status, defined using the US Food Security Survey Module. Multivariable linear regression was used to estimate the association between food security status and the DII score and moderation by demographic factors. Survey weighting procedures accounted for the effects of stratification and clustering used in the NHANES study design.

Results When accounting for socioeconomic status, demographic factors, and health status, DII score was higher at greater levels of food insecurity (P=0.0033). Those with very low food security had a 0.31 (95% CI=0.12 to 0.49) higher DII score than those with high food security. Age moderated the association between food security status and DII score (interaction P=0.0103), where the magnitude of the association between DII score and severity of food insecurity was higher for those >65 years than for younger age groups.

Conclusion Food security status may be associated with dietary inflammatory potential, which is hypothesized to play a role in multiple chronic health conditions. Further research is needed to determine the causal nature of this relationship and evaluate how best to implement programs designed to address health disparities within food insecure populations.
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FOOD INSECURITY, DEFINED AS A LACK OF ACCESS TO food of sufficient quality or quantity due to financial constraints,[1] affects 14% of the US population.[2] Food insecurity is associated with numerous negative health outcomes among adults including a host of complex chronic conditions such as heart disease, diabetes, hypertension, hyperlipidemia, and poor mental health and depression.[3-5] However, the underlying biological mechanisms and pathways by which food insecurity influences health are not well understood.

Immune-inflammatory pathways represent a potential link between food insecurity and multiple chronic diseases. Inflammation is an important element of the immune response and is necessary to protect against external pathogens and repair tissue damaged by infection or trauma.[6] However, certain factors can lead to the development of systemic inflammation, which is considered important in the development of cancer,[7] cardiovascular disease,[8] and type II diabetes.[9] Compelling evidence suggests that systemic inflammation may also result in neurodegenerative and neuropsychiatric illnesses.[7,10,11] Thus, identifying socio-environmental or behavioral factors such as food insecurity that contribute to the activation of systemic inflammation and the production of inflammatory cytokines may inform novel intervention strategies.

Multiple aspects of food insecurity have the potential to result in systemic inflammation. The psychological stress and emotional strain associated with experiencing food insecurity enhances the innate immune response and increases production of proinflammatory cytokines.[12] In addition, food insecurity is believed to increase the risk for obesity because nutrient-poor, calorically dense foods are often more affordable than healthier options,[13] and inflammatory markers present in adipose tissue can spread to the rest of the body.[14] Furthermore, diet itself may be an important source of systemic inflammation.

Nutrients obtained through diet, such as flavonoids, zinc, and n-6 fatty acids, have anti-inflammatory properties shown to reduce most chronic disease risk.[15-17] In addition, diets rich in saturated fats and low in fruits and vegetables are believed to be pro-inflammatory compared with diets with fewer saturated fats and high in fiber rich foods including fruits and vegetables.[18,19] It is well established that food insecure individuals consume fewer fruits, vegetables, and dairy products and have significantly lower intake of vitamins A and B-6, calcium, magnesium, and zinc.[20] Despite this supporting evidence, limited research has directly evaluated whether food insecurity is predictive of overall dietary inflammatory potential or examined the role dietary inflammatory potential may play in mediating the relationship between food insecurity and adverse health outcomes.

A novel strategy to quantify the total inflammatory potential of diet has been developed for use across multiple studies of diet and health.[21,22] Originally produced by Cavicchia and colleagues and refined by Shivappa and colleagues, the Dietary Inflammatory Index (DII) is designed to estimate the degree to which diet induces or suppresses inflammatory pathways, by leveraging dietary intake data, which attempts to provide an accurate picture of foods regularly consumed by an individual.[21,22] Hypothetically, the ideal strategy for assessing an individual's dietary inflammatory potential would be to determine the amount of energy and nutrients available for metabolism from foods consumed over a long period of time.[23] In general, this is not a feasible data collection approach, especially at the scale required by large population-based studies. Thus, the ability to estimate the inflammatory potential of diet with widely used dietary intake tools provides an appealing alternative.[22]

As described in detail by Shivappa and colleagues,[22] the DII is based on a meta-analysis of 1,943 articles that assessed the impact of whole foods, nutrients, and bioactive compounds on inflammatory markers, specifically interleukin (IL)-1β, IL-4, IL-6, IL-10, tumor necrosis factor α, and C-reactive protein (CRP). Eligible articles were weighted based on study design, and food parameters were assigned an inflammatory effect score based on whether associations with biomarkers were pro- or anti-inflammatory. A negative inflammatory effect score means that a food parameter is considered anti-inflammatory (eg, fiber, polyunsaturated fatty acids), and a positive inflammatory effect score means that a food parameter is considered proinflammatory (eg, saturated fat, total kilocalories). Likewise, an individual's total DII score can range from negative values, indicating an overall anti-inflammatory diet, to positive values, indicating an overall pro-inflammatory diet. The association between DII score and circulating levels of inflammatory markers CRP and IL-6 has been validated in previous population-based studies, including the National Health and Nutrition Examination Survey (NHANES).[24-27]

The use of the DII differs from nutritional epidemiology studies that assess single nutrients in isolation, which are unable to consider complex interactions between foods that may impact inflammation differently.[28] The DII approach also differs from methods examining dietary patterns (eg, Mediterranean diet, Western diet) that group individuals based on consumption of certain foods in combination but are not characterized by their potential to influence underlying biological mechanisms.[29] DII score has previously been associated with circulating levels of proinflammatory biomarkers,[24,30] depression and other measures of mental health,[31-35] cardiovascular disease and metabolic conditions,[36-38] and multiple cancers.[39-41]

This study examines whether food security status is associated with DII score within a large representative sample of lower-income US adults. This study also investigates whether this association is moderated by important demographic characteristics: marital status, sex, and age group. Evidence indicates that the experience of food insecurity differs by demographic factors. For example, a socioeconomically disadvantaged single mother that is food insecure may be likely to decrease her consumption of food or go without to provide for her children[42] and, therefore, may be more likely to consume calorically dense, nutrient-poor foods with a higher inflammatory potential to feel satiated. Alternatively, a higher prevalence of functional impairment among food insecure

RESEARCH SNAPSHOT

Research Question: Is food security status associated with dietary inflammatory potential?

Key Findings: In this cross-sectional cohort of 10,630 adults from the United States National Health and Nutrition Examination Survey (NHANES) 2007 to 2014 cycles, food security status was associated with dietary inflammatory potential, measured using the Dietary Inflammatory Index (DII). When accounting for socioeconomic status, demographic factors, and health status, DII score was higher at greater levels of food insecurity (P=0.0033). Those with very low food security had a 0.31 (95% CI=0.12 to 0.49) higher DII score than those with high food security.