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Effect of Food Insecurity on Chronic Kidney Disease in Lower-Income Americans

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Key Words
Socioeconomic status · Disparity · Nutrition

Abstract
Background: The relation of food insecurity (inability to acquire nutritionally adequate and safe foods) and chronic kidney disease (CKD) is unknown. We examined whether food insecurity is associated with prevalent CKD among lower-income individuals in both the general US adult population and an urban population. ***Methods:*** We conducted cross-sectional analyses of lower-income participants of the National Health and Nutrition Examination Survey (NHANES) 2003–2008 (n = 9,126) and the Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) study (n = 1,239). Food insecurity was defined based on questionnaires and CKD was defined by reduced estimated glomerular filtration rate or albuminuria; adjustment was performed with multivariable logistic regression. ***Results:*** In NHANES, the age-adjusted prevalence of CKD was 20.3, 17.6, and 15.7% for the high, marginal, and no food insecurity groups, respectively. Analyses adjusting for sociodemographics and smoking status revealed high food insecurity to be associated with greater odds of CKD only among participants with either diabetes (OR = 1.67, 95% CI: 1.14–2.45 comparing high to no food insecurity groups) or hypertension (OR = 1.37, 95% CI: 1.03–1.82). In HANDLS, the age-adjusted CKD prevalence was 5.9 and 4.6% for those with and without food insecurity, respectively (p = 0.33). Food insecurity was associated with a trend towards greater odds of CKD (OR = 1.46, 95% CI: 0.98–2.18) with no evidence of effect modification across diabetes, hypertension, or obesity subgroups. ***Conclusion:*** Food insecurity may contribute to disparities in kidney disease, especially among persons with diabetes or hypertension, and is worthy of further study.

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Introduction

Low socioeconomic status (SES) is associated with prevalent chronic kidney disease (CKD) [1–7] and increased risk of end-stage renal disease [8, 9]. However, few studies have addressed the correlates of low SES which might lead to CKD; therefore, little progress has been made towards the elimination of socioeconomic disparities in CKD.

Food insecurity may accompany low SES, and has been defined as 'limited or uncertain ability to acquire nutritionally adequate and safe foods in socially acceptable ways' [10]. In 2010, 17 million US households were food insecure [11]. Food insecurity is associated with greater prevalence of several diet-related chronic conditions, including diabetes, hypertension, and obesity [12, 13]. However, little is known about the relation of food insecurity and CKD.

Food insecurity might lead to CKD through its influence on the development and management of risk factors for CKD (e.g. diabetes and hypertension) or through direct effects of diet on the kidney [14]. For example, acid-inducing diets (i.e. limited fruits and vegetables) may lead to endothelin-mediated glomerulosclerosis and fibrosis [15, 16]. In contrast, diets rich in fruits and vegetables have been associated with attenuated kidney injury [17, 18] and lower risk of CKD progression [19]. Food insecurity is associated with limited fruit and vegetable intake [20]. Elucidating the relation of food insecurity and CKD could advance understanding of the mechanisms through which low SES may lead to CKD. Therefore, we sought to describe this association among lower-income individuals in the general US adult population and in an urban population selected on the basis of SES. We hypothesized that because the types and cost of foods available to urban versus other population groups may differ (e.g. greater availability of 'fast foods' in urban areas), food insecurity may be more strongly associated with prevalent CKD in an urban population.

Methods

National Health and Nutrition Examination Survey: Design and Population

We examined combined data from the 2003–2004, 2005–2006, and 2007–2008 survey periods of the National Health and Nutrition Examination Survey (NHANES), which were conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention to examine disease trends in representative samples of noninstitutionalized US civilian residents [21]. The survey consists of a standardized in-home interview and a physical examination and blood and urine collection at a mobile examination center (MEC). Participants gave informed consent. The protocol was approved by the NCHS Research Ethics Review Board.

Our population of interest was US adults aged 20 years or older who had a household income <400% of the federal poverty level [in order to exclude higher-income persons unlikely to experience food insecurity (as in previous studies [13, 22])]. The MEC sample included 15,222 participants who were at least 20 years of age. Of these, 14,358 had food insecurity data available and were not pregnant. A total of 10,354 participants from this sample met our household income criteria. We excluded those with missing serum creatinine, urine albumin, or urine creatinine (n = 841) and those with estimated glomerular filtration rate (eGFR) <15 ml/min/1.73 m^2 (n = 387), resulting in a final analytic sample of 9,126 participants.

NHANES: Measurements and Definitions

Food insecurity was assessed using a 10-item questionnaire, and scored responses were released by the NHANES as 4 categories, which we regrouped into 3 categories and labeled as: no (0 affirmative responses), marginal (1–2), and high (3–10) food insecurity. We used only those items pertaining to the adults in the household. Questionnaire items included, 'In the last 12 months, I couldn't afford to eat balanced meals' and 'Did you ever cut the size of your meals or skip meals because there wasn't enough money for food'. Self-reported demographics (age, sex, race/ethnicity, and marital status), SES (education, insurance, and income), health behaviors (smoking), and health conditions (hypertension and diabetes mellitus) were obtained during the interview portions of the surveys. Income was assessed using the poverty-income ratio, a ratio of household income to household poverty level [23]. Height and weight, used to calculate BMI, were measured on the MEC, and those with a BMI >30 were classified as obese. Participants with self-reported diabetes or measured nonfasting plasma glucose ≥200 mg/dl were classified as having diabetes. Participants with a self-report of hypertension or measured average systolic blood pressure ≥140 or diastolic blood pressure ≥90 mm Hg were classified as having hypertension [24]. Serum creatinine was measured by the modified kinetic method of Jaffe using different analyzers in different survey years. Random spot urine samples were obtained, and urine albumin and creatinine were measured using frozen specimens. Urine albumin was measured using a solid-phase fluorescence immunoassay; urine creatinine was measured using the modified Jaffe kinetic method in the same laboratory.

CKD was defined using eGFR and the presence of albuminuria, based on Kidney Disease Outcomes Quality Initiative (KDOQI) guidelines [25]. eGFR was calculated using the modified Modification of Diet in Renal Disease Study equation for calibrated creatinine [26, 27]. Calibration equations adhering to the Cleveland Clinic protocol were applied to serum creatinine values obtained in 2005–2006 and to urine creatinine values obtained in 2003–2004 and 2005–2006 [28]. Albuminuria was considered present at urinary albumin-to-creatinine ratios ≥30 mg/g. CKD was defined as eGFR <60 ml/min per 1.73 m^2 or albuminuria.

Healthy Aging in Neighborhoods of Diversity across the Life Span: Design and Population

We examined cross-sectional data from the National Institute on Aging (NIA), Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) study. HANDLS is a population-based cohort study of the influences and interaction of race and SES on the development of health disparities among minority and lower SES subgroups [29]. Participants are community-dwelling African Americans and Whites 30–64 years of age at enrollment, drawn from 13 neighborhoods, each composed of contiguous US census tracts in Baltimore, Md., to reflect socioeconomic and racial diversity. HANDLS participants were sampled representatively using a factorial cross of 4 factors (age, sex, race, and SES) with approximately equal numbers of participants in each 'cell'. Enrollment was from 2004 to 2008. Each participant provided informed consent. The MedStar Research Institute Institutional Review Board approved the study protocol.

Although the total HANDLS population is 3,720, in the present study, we restricted our analysis to participants who (1) completed fasting laboratory testing (n = 2,708), (2) had available data on food insecurity (n = 2,191), (3) had an annual household income less than USD 75,000 (400% of the poverty level for a family of 4) [30] (n = 1,923), (4) had available data on urinary albumin-to-creatinine (n = 1,240), and (5) had an eGFR ≥15 ml/min per 1.73 m^2 (final n = 1,239).

HANDLS: Measurements and Definitions

Food insecurity was assessed using the NHANES 1999–2000 food insecurity questionnaire [31]. Because this early version of the questionnaire did not include a comparable scoring system to that of the more recent NHANES questionnaire, we defined food insecurity based upon an affirmative response to, 'In the last 12 months, did you or your household ever cut the size of your meals or skip meals because there wasn't enough money for food?'. This question was included in both the NHANES and HANDLS questionnaires (online suppl. appendix A; for all online suppl. material, see www.karger.com/doi/10.1159/000357595), and in 2011, 97% of US adults who had food insecurity with hunger answered this question affirmatively [32]. Demographic data including, age, sex, race, employment, and educational status were assessed during an initial household survey. Poverty status was based on reported annual household income below or above 125% of the 2004 Department of Health and Human Services poverty guideline [30], and was determined at baseline in the HANDLS study to allow for selection of a representative sample [29]. A mobile research vehicle was the site of health care provider-ascertained medical and social history (including smoking history) and physical examination. Fasting venous blood specimen and spot urine samples were collected in the mobile research vehicle and analyzed at the NIA Clinical Research Branch Core Laboratory (Baltimore, Md., USA) and Quest Diagnostics Inc. (Baltimore, Md., and Chantilly, Va., USA). Hypertension was defined as an average of seated and standing systolic blood pressure ≥140 mm Hg, an average of seated and standing diastolic blood pressure ≥90 mm Hg [24], a history of blood pressure medication use, and/or a self-report of hypertension. Diabetes mellitus was defined as a fasting plasma glucose concentration of ≥126 mg/dl (7.0 mmol/l) [33] or self-report of diabetes. Height and weight were measured and used to calculate BMI to determine the presence of obesity (BMI ≥30).

Serum creatinine was measured at Quest Diagnostics Inc. by isotope dilution mass spectrometry (Olympus America Inc., Melville, N.Y., USA) and standardized to the reference laboratory at the Cleveland Clinic. The urine microalbumin concentration was measured at Quest Diagnostics Inc. using an immunoturbidimetric assay (Kamiya Biomedical Co., Seattle, Wash., USA). CKD was defined as in NHANES.

Statistical Methods

To account for the complex design in NHANES, including weights, clusters, and strata, all analyses for NHANES were performed using survey procedures. Six-year weights were calculated as the 2-year MEC weight multiplied by 1/3. For both studies, participant characteristics stratified by food insecurity status were compared using descriptive statistics. In NHANES, for categorical variables, survey-weighted percentages and standard errors were calculated and tested for study group differences using Rao-Scott χ^2 tests. For continuous variables, weighted means and standard errors were calculated and tested for study group differences using analysis of variance. In HANDLS, participant characteristics were compared using Fisher's exact tests for categorical variables and t tests for continuous variables.

Multivariable logistic regression was used to calculate age-adjusted prevalence of CKD, stratified by food insecurity status, and to determine the magnitude and direction of the relation between food insecurity and CKD. In NHANES, we compared the high and marginal food insecurity groups to the no food insecurity group, and sequentially adjusted for age, sex, race, education, marital status, health insurance, poverty-income ratio, smoking status, diabetes, hypertension, and obesity. In HANDLS, we compared the food insecurity to the no food insecurity group and adjusted for similar variables to NHANES (poverty status was used, as opposed to poverty-income ratio). Selected confounders were related to either food insecurity or CKD in previous studies, including reports from NHANES [26] and HANDLS [1]. Model-wise deletion was used to handle missing data in the HANDLS models (variables were missing at 3.6% or less).

Subgroup analyses by diabetes, hypertension, and obesity status were performed to determine if food insecurity was differentially related to CKD across these groups. An interaction between food insecurity and each subgroup was considered in the aforementioned models.

In a sensitivity analysis, we used the CKD Epidemiology Collaboration (CKD-EPI) equation [34] to estimate GFR in our primary definition of CKD. Stata, version 11 (StataCorp, College Station, Tex., USA) was used for all analyses. In HANDLS, the possibility of confounding by neighborhood was controlled with fixed-effects modeling [35]. A two-sided $p < 0.05$ was used as the level of significance for all tests.

Results

National Health and Nutrition Examination Survey

Among US adults aged 20 years and older and with a household income <400% of the poverty level in 2003–

Table 1. Population characteristics by food insecurity status, NHANES 2003–2008

Characteristic	All	Food insecurity			p value
		no	marginal	high	
Total	9,126	74%	11%	15%	–
Age, years	46.6±0.4	48.4±0.5	41.6±0.7	41.6±0.5	<0.001
Male	47%	47%	46%	47%	0.59
Race/ethnicity					<0.001
Mexican American	11%	8%	21%	17%	
Non-Hispanic White	65%	71%	46%	49%	
Non-Hispanic Black	13%	11%	19%	18%	
Poverty-income ratio[a]	2.0±0.03	2.2±0.03	1.6±0.05	1.3±0.04	<0.001
Insured	74%	79%	61%	59%	<0.001
Education ≥12th grade	74%	78%	65%	60%	<0.001
Current tobacco use	28%	24%	36%	41%	<0.001
Comorbid conditions					
Hypertension	39%	41%	34%	36%	0.006
Diabetes	9%	9%	9%	10%	0.292
Obesity	35%	33%	38%	38%	0.009

US adults age ≥20 years with annual household income <400% of the federal poverty guideline. Values represent means ± standard error unless otherwise indicated. [a] Poverty-income ratio is a ratio of household income to household poverty level (higher values indicate greater income).

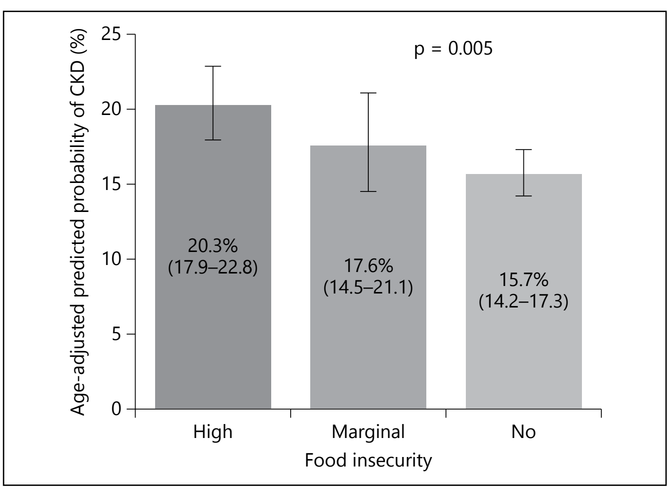

Fig. 1. Age-adjusted prevalence of CKD by food insecurity status, NHANES 2003–2008 (US adults age ≥20 years with income <400% of the federal poverty guideline). p = 0.005.

2008, 74% reported no food insecurity, 11% marginal food insecurity, and 15% high food insecurity. Those with high or marginal food insecurity were younger, less likely to be of non-Hispanic White race/ethnicity, less likely to be insured, and/or less likely to have completed at least a 12th grade education than were those with no food insecurity. Conversely, individuals with high or marginal food insecurity were more likely to be smokers and have obesity and/or hypertension. Income level declined across food insecurity categories, with the high food insecurity group having the lowest mean poverty-income ratio (table 1).

Age-adjusted prevalence of CKD was 20.3, 17.6, and 15.7% for the high, marginal, and no food insecurity individuals, respectively (fig. 1). Logistic regression models including adjustment for age, sex, and race revealed greater food insecurity to be associated with statistically significantly greater odds of CKD (table 2). Upon further adjustment for sociodemographic factors and comorbid conditions, there was no significant association between food insecurity and CKD. Logistic regression models inclusive of adjustment for sociodemographic factors (age, race/ethnicity, sex, education, marital status, insurance, poverty-income ratio, and smoking status) and stratified by diabetes, hypertension, and obesity status revealed high food insecurity to be associated with greater odds of CKD only among the subgroups with either diabetes (OR = 1.67, 95% CI: 1.14–2.45) or hypertension (OR = 1.37, 95% CI: 1.03–1.82; fig. 2).

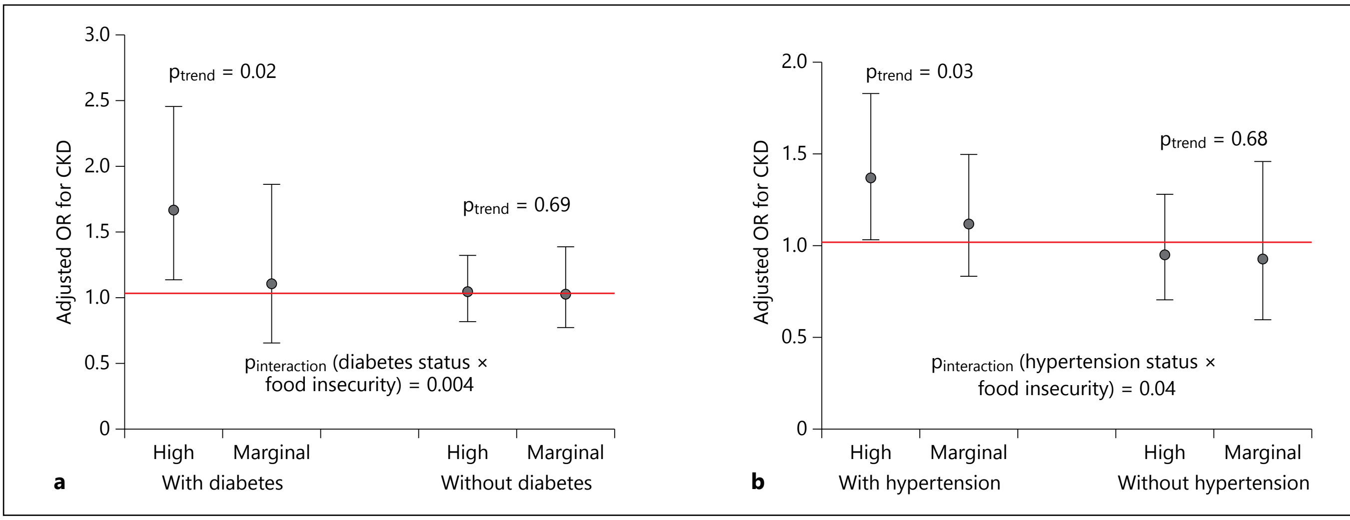

Fig. 2. a Adjusted OR for CKD comparing high or marginal food insecurity groups to the no food insecurity group (reference) among lower-income persons with or without diabetes, NHANES 2003–2008 [adjusted for sociodemographic factors (age, race/ethnicity, sex, education, marital status, insurance, poverty-income ratio, and smoking status)]. **b** Adjusted OR for CKD comparing high or marginal food insecurity groups to the no food insecurity group (reference) among lower-income persons with or without hypertension, NHANES 2003–2008 [adjusted for sociodemographic factors (age, race/ethnicity, sex, education, marital status, insurance, poverty-income ratio, and smoking status)].

Healthy Aging in Neighborhoods of Diversity across the Life Span Study

There were 1,239 HANDLS participants included in our analysis. Among them, 27% reported food insecurity. The age range of participants was 30–64 years. Participants with food insecurity were younger, less likely to be male, employed, or insured, and less likely to have completed at least a 12th grade education than were participants with no food insecurity. Conversely, participants with food insecurity were more likely to live in poverty or use tobacco. There were no differences in race or comorbid conditions across food insecurity groups in HANDLS (table 3).

The age-adjusted prevalence of CKD was 5.9% for the food insecurity and 4.6% for the no food insecurity participants ($p = 0.33$). A logistic regression model (model 1) including adjustment for age, sex, and race revealed food insecurity to be associated with greater odds of CKD, which was not statistically significant (OR = 1.27, 95% CI: 0.84–1.92). Upon further adjustment (model 2) for other sociodemographic factors (education, poverty status, insurance, and marital status), there was a significant association between food insecurity and CKD (OR = 1.54, 95% CI: 1.10–2.16), largely influenced by the addition of insurance status to model 1. Insured participants were more likely to have CKD than uninsured individuals.

Table 2. Relation of food insecurity status to CKD, NHANES 2003–2008 from logistic regression analyses

Model	Adjusted for	Food insecurity	OR (95% CI) for CKD	p value for trend
1	age, sex, race	high	1.35 (1.09–1.67)	0.007
		marginal	1.14 (0.88–1.48)	
		no	1.0 (reference)	
2	+ education, marital status, insurance, poverty-income ratio[a], smoking status	high	1.24 (1.00–1.53)	0.05
		marginal	1.09 (0.84–1.41)	
		no	1.0 (reference)	
3	+ diabetes, hypertension, obesity	high	1.06 (0.86–1.31)	0.59
		marginal	1.00 (0.74–1.35)	
		no	1.0 (reference)	

[a] Poverty-income ratio is a ratio of household income to household poverty level (higher values indicate greater income).

Upon further adjustment for tobacco use and comorbid conditions (diabetes, hypertension, and obesity), the association of food insecurity and CKD was attenuated to statistical nonsignificance (OR = 1.46, 95% CI: 0.98–2.18). Logistic regression models stratified by diabetes,

Table 3. Participant characteristics by food insecurity status, HANDLS

Characteristic	n for analysis	All	No food insecurity	Food insecurity	p value
Total	1,239	1,240	902 (73)	338 (27)	–
Age in years	1,239	47.8±9.4	48.6±9.4	45.9±9.0	<0.001
Male	1,239	544 (44)	417 (46)	127 (38)	0.007
Black race	1,239	633 (51)	462 (51)	171 (51)	0.85
Poverty status[a]	1,239	412 (33)	260 (29)	152 (45)	<0.001
Ever married	1,192	723 (61)	533 (62)	190 (58)	0.19
Currently employed	1,193	735 (62)	574 (67)	161 (49)	<0.001
Education ≥12th grade	1,193	833 (70)	628 (73)	205 (62)	<0.001
Insured	1,193	804 (67)	618 (72)	186 (56)	<0.001
Current tobacco use	1,199	581 (48)	394 (45)	187 (57)	<0.001
Comorbid conditions					
Hypertension	1,237	550 (44)	393 (440)	157 (46)	0.40
Diabetes	1,236	272 (22)	199 (22)	73 (22)	0.88
Obesity	1,237	550 (44)	393 (44)	157 (46)	0.40

Values represent n (%) or means ± SD. [a] Poverty status defined as annual household income below 125% of the 2004 Department of Health and Human Services poverty guideline [30].

hypertension, and obesity status revealed no statistically significant effect modification; however, there was a trend towards a greater association of food insecurity with CKD among participants with either hypertension or obesity (online suppl. appendix B).

Sensitivity Analysis

In NHANES, the age-adjusted prevalence of CKD by the CKD-EPI equation was 18.9, 17.1, and 14.2% for the high, marginal, and no food insecurity participants, respectively ($p < 0.001$). Logistic regression models yielded similar results to our primary analysis, as they did in HANDLS (data not shown).

Discussion

Among both the general and urban population of lower-income US adults, we found that approximately one quarter of the individuals were food insecure, and food insecurity was associated with CKD. The relation was nuanced, with food insecurity having an independent relation with greater prevalence of CKD only among individuals with diabetes or hypertension in the general population, but with no statistically significant, independent relation with CKD in an urban population. Our results persisted with adjustment for correlates of low SES, and were similar using both the MDRD study and CKD-EPI equations for GFR estimation.

To our knowledge, this is the first report describing the relationship between food insecurity and CKD. In developing countries, food insecurity often leads to *undernutrition* and frank starvation [33, 35]. However, in the USA, it is correlated with *overnutrition* (severe overconsumption of energy) [36]. Thus, individuals with food insecurity are more likely to be overweight or obese due to increased intake of energy-dense foods (i.e. rich in fat and sugar) and limited intake of fruits, vegetables, and fiber [20, 37]. Downstream from obesity, food-insecure persons are at risk of type 2 diabetes [22] and have worse glycemic control than those with no food insecurity [38]. This could potentially explain the differential relation between food insecurity and CKD we observed between diabetic and nondiabetic individuals in the general population. It is possible that food insecurity only plays an additive detrimental role in the development of CKD (beyond that conferred by low-income status alone) in the setting conditions such as diabetes and hypertension.

Our observation of general consistency across clinical subgroups in the HANDLS study, in comparison to the effect modification noted above in NHANES, might reflect design differences across the two studies (i.e. differences in sample size, and in the age distribution of the 2 studies, which likely explains the lower prevalence of CKD among HANDLS participants), but could underscore variations in food availability and dietary practices in the general and urban populations. Food deserts ('areas in the US with limited access to affordable and nutritious food') are common in Baltimore, Md. [39, 40], where the

HANDLS study is conducted. Moreover, 'food swamps' (geographic areas where the overabundance of high-energy foods inundate healthy food options [41]) are also common in metropolitan areas [39]. Food-insecure individuals in these areas may preferentially purchase such energy-dense foods because they are (1) often less expensive than healthier choices [42], (2) may be more palatable than healthy foods [43], and (3) may be easier to prepare in kitchens with inadequate appliances [12]. These foods often contain sodium-based food additives, which in the USA come primarily from processed breads, cereals, grains, meats, sauces, and canned items [12], and account for 75% of total sodium intake [44]. Excessive sodium intake is a risk factor for adverse CKD outcomes [45].

Our study had some limitations. First, as cross-sectional analyses, causality cannot be inferred, and reverse causality (CKD leading to food insecurity, e.g. from loss of employment due to disability) is possible. Second, we used two different approaches to measuring the presence of food insecurity given differences in data collection in our two study populations. Third, due to sample size considerations (especially in HANDLS) we lacked granularity in some covariates examined (e.g. health insurance status). Fourth, we did not account for differences in dietary patterns. Finally, we did not include a measure of food insecurity among children in the homes of participants (not assessed in HANDLS), which might influence adults' approaches to managing food insecurity [46].

Despite its limitations, our study findings could have important implications. The global prevalence of risk factors for CKD, including hypertension and diabetes, has been rising and poverty has been implicated as a contributor [47]. An estimated 1.2 billion persons worldwide live in extreme poverty (earning less than USD 1/day) [48], and over 900 million persons in the world are undernourished [49]. While understudied, it is therefore conceivable that food insecurity could be a contributor to the worldwide prevalence of CKD, which is estimated to affect 10–16% of adults [25, 50–54].

In the clinical setting, as providers aim to inform patients of their CKD risk profile and individually tailor their management plan, it may be important to assess potential barriers or competing priorities to following lifestyle recommendations. As such, a simple screening question regarding food insecurity (e.g. 'have you had to skip meals because there wasn't enough money?') could allow identification of patients at increased risk for CKD and guide dietary recommendations. Longitudinal studies in this area are needed to more closely examine food insecurity, consequent dietary patterns, and CKD. Further, tailored dietary interventions among food-insecure individuals could serve to mitigate disparities in CKD.

In conclusion, food insecurity is associated with CKD, particularly among lower-income individuals with either diabetes or hypertension. Thus, food insecurity may play a role in disparities in CKD and its further study could present opportunities for intervention.

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Appendix A. Food Insecurity Questionnaire Items

NHANES

Item Label (HH=Household)	Full Question
HH Worried run out of food	"…please tell me whether the statement was often true, sometimes true, or never true for {you/your household} in the last 12 months--{I/we} worried whether {my/our} food would run out before {I/we} got money to buy more."
HH Food didn't last	"…please tell me whether the statement was often true, sometimes true, or never true for {you/your household} in the last 12 months--The food that {I/we} bought just didn't last, and {I/we} didn't have money to get more."
HH Couldn't afford balanced meals	"…please tell me whether the statement was often true, sometimes true, or never true for {you/your household} in the last 12 months--{I/we} couldn't afford to eat balanced meals."
HH Adults cut size or skip meals	"In the last 12 months, since last, did {you/you or other adults in your household} ever cut the size of your meals or skip meals because there wasn't enough money for food?"
HH How often adults cut size/skip meals	"How often did this happen?"
HH Eat less than should	"In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money to buy food?"
HH Hungry, but didn't eat	"[In the last 12 months], were you ever hungry but didn't eat because you couldn't afford enough food?"
HH Lost weight, no money for food	"[In the last 12 months], did you lose weight because you didn't have enough money for food?"
HH Adults not eat whole day	"In the last 12 months], did {you/you or other adults in your household} ever not eat for a whole day because there wasn't enough money for food?"
HH How often adults not eat for day	"How often did this happen? Would you say . . ."

HANDLS

Which of these statements best describe the food eaten by you and your family in the last 12 months?

0 Always have enough

1 Enough, not what I want

2 Sometimes not enough

3 Often not enough

7 DK

9 NA

I have transportation problems that prevent me from always having enough to eat.

0 No

1 Yes

7 DK

9 NA

I have transportation problems that prevent me from always having the kinds of food I want or need.

0 No

1 Yes

7 DK

9 NA

I do not have enough money, food stamps, or WIC vouchers to buy enough food to eat.

0 No

1 Yes

7 DK

9 NA

I do not have enough money, food stamps, or WIC vouchers to buy the kinds of food I want or need.

0 No

1 Yes

7 DK

9 NA

I do not have enough food to eat because I am on a diet.

0 No

1 Yes

7 DK

9 NA

I do not have the kinds of food I want or need because I am on a diet

0 No

1 Yes
7 DK
9 NA

I do not have enough food to eat because I do not have a working stove or refrigerator.

0 No
1 Yes
7 DK
9 NA

I do not have the kinds of food I want or need because I do not have a working stove or refrigerator.

0 No
1 Yes
7 DK
9 NA

I do not have enough food to eat because I have health problems that prevent me from cooking or eating.

0 No
1 Yes
7 DK
9 NA

I do not always have the kinds of food I want or need because I have health problems that prevent me from cooking or eating.

0 No
1 Yes
7 DK
9 NA

I do not have enough food to eat because the kinds of food I want are not available.

0 No
1 Yes
7 DK
9 NA

I do not always have the kinds of food I want or need because the kinds of food I want are not available.

0 No
1 Yes
7 DK
9 NA

I do not have enough food to eat because good quality food is not available.

0 No
1 Yes
7 DK
9 NA

I do not always have the kinds of food I want or need because good quality food is not available.

0 No
1 Yes
7 DK
9 NA

In the last 12 months, did you or your household ever cut the size of your meals or skip meals because there wasn't enough money for food?

0 No
1 Yes
7 DK
9 NA

In the last 12 months, how often did you or your household cut the size of your meals or skip meals because there wasn't enough money for food?

0 Almost every month
1 Some months, not every month
2 Only 1 or 2 months
7 DK
9 NA

Appendix B.

Table B1. Relation of Food Insecurity Status to CKD, HANDLS from Logistic Regression Analyses

Model	Variables Included	Odds Ratio (95% Confidence Interval) for CKD comparing Food Insecurity to No Food Insecurity Groups
1	age, sex and race	1.27 (0.84-1.92)
2	+education, *poverty status, insurance, marital status	1.54 (1.10-2.16)
3	+tobacco use, diabetes, hypertension, obesity	1.46 (0.98-2.18)

*Poverty status defined as annual household income below 125% of the 2004 Department of Health and Human Services poverty guideline

Table B2. Adjusted Odd Ratios for CKD Comparing Food Insecurity and No Food Insecurity Groups among Chronic Condition Subgroups, HANDLS
[Adjusted for sociodemographic characteristics (age, sex, race, education, poverty status, insurance, marital status) and tobacco use]

Subgroup	Food Insecurity	Odds Ratio for CKD (95% Confidence Interval)	Subgroup	Odds Ratio for CKD (95% Confidence Interval)	P interaction (chronic condition X food insecurity)
With Diabetes	Yes	1.13 (0.50-2.55)	Without Diabetes	1.88 (1.15-3.06)	0.58
	No	reference		reference	
With Hypertension	Yes	1.69 (0.99-2.89)	Without Hypertension	0.73 (0.30-1.76)	0.28
	No	reference		reference	
With Obesity	Yes	2.54 (1.04-6.22)	Without Obesity	0.89 (0.44-1.82)	0.30
	No	reference		reference	