Association Between Household Food Insecurity and Nephrolithiasis by Family Income Levels in the United States

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Background

Nephrolithiasis, also known as kidney stones, is a common condition caused by the hard chemical deposits that form in one or both kidneys, posing a public health burden in the United States (US) in recent years (Scales et al., 2012). The prevalence of kidney stones in the US has increased from 5.2% in the late 1980s to 11% in 2015-2018, with an estimated 12-month kidney stone incidence of 2.1%, or 2054 stones per 100,000 adults (Stamatelou et al., 2003; Hill et al., 2022). While several demographic factors, such as age, gender, and socioeconomic status, influence kidney stone development, lifestyle factors, such as diet and smoking, along with comorbidities, such as diabetes, hypertension, and obesity, amplify the risk of stone formation and recurrence (Simmons et al., 2023; Wang et al., 2022). Previous research has also linked the risk of kidney stone formation to certain dietary factors, beverage consumption, and general dietary intake, with certain types of fluids, such as sugar-sweetened beverages, and high-sodium diets being major contributors (Ferraro et al., 2013).

Food insecurity, defined as limited access to adequate and nutritious food, is a significant social determinant of health that disproportionately affects millions of US households. In the US, 13.5% of households were food insecure in 2023, with elevated rates among minority populations and households with low socioeconomic status (Rabbitt et al., 2024). Individuals with food insecurity often consume cheaper, processed foods that are low in essential nutrients, as well as fewer fruits and vegetables due to limited resources (Gundersen & Ziliak, 2015). These dietary patterns heighten the risk of chronic conditions, such as cardiovascular disease, obesity, and diabetes, all of which are also risk factors for nephrolithiasis (Cheungpasitporn et al., 2014; Stamatelou & Goldfarb, 2023).

As food insecurity influences dietary patterns, it is also associated with the risk of nephrolithiasis. Food insecurity is linked to greater consumption of energy-dense foods, higher intake of fat and sugar items, and increased reliance on inexpensive, processed, or quick-cooked frozen foods, all of which negatively affect diet quality (Morales & Berkowitz, 2016). Calcium oxalate, the most common type of kidney stone, is likely to form in the kidneys due to high dietary sodium intake, which increases urinary calcium excretion and decreases urinary citrate (Peerapen & Thongboonkerd, 2023). Limited research established the link between food insecurity and nephrolithiasis, which suggests that households experiencing low food security are more likely to have individuals at risk of having kidney stones (Wang et al., 2022; Green et al., 2022). However, given that lower socioeconomic status is associated with higher rates of food insecurity, it's important to examine the relationship between food insecurity and nephrolithiasis, as well as how this relationship may vary across individuals within households at different family income levels.

Thus, the present study aims to examine the prevalence of nephrolithiasis in a nationally representative sample of US adults, and stratified by food security status. The association between food insecurity and nephrolithiasis will also be investigated by family income level. I hypothesize that (1) food insecurity is associated with increased odds of kidney stone disease, and (2) the association is stronger among adults with low family income compared to those with high family income.

Methods

This study is a cross-sectional analysis using data from the National Health and Nutrition Examination Survey (NHANES). NHANES is a continuous, nationally representative survey of the non-institutionalized civilian population in the United States that uses a complex probability sampling design to collect health and nutritional information (NHANES Survey Methods and Analytic Guidelines, 2021). Three consecutive cycles of data from 2013 to 2018 were extracted from NHANES, as the combined cycle provides consistent data on the variables of interest, including food security and kidney stone history. While NHANES includes data from 2017 to March 2020, the 2019-2020 cycle is incomplete due to disruptions in data collection during the COVID-19 pandemic; therefore, the collected data during this cycle are not nationally representative. Additionally, the 08/2021-08/2023 data cycle does not include questions regarding food security status and kidney stones. The 2013 to 2018 cycles ensure full data coverage and maintain methodological consistency. The study population was limited to adults with complete recorded information on kidney stone history and household food security. Participants with incomplete data on these variables of interest were excluded from the analysis. The final sample size for analysis was 16,418 adults with complete data available on outcome, exposure, and covariates.

Measures

Nephrolithiasis. The outcome of interest was kidney stones. Respondents were asked whether they had ever had kidney stones via a questionnaire item from the NHANES Kidney Conditions section, which includes personal interview information on kidney disease, kidney stones, urinary incontinence, and nocturia. Individuals who answered “yes” were classified as having a history of nephrolithiasis, and those who reported “no” were classified as not having the outcome. “Don’t know” or refused responses were treated as missing and were excluded from the analysis. Prior studies have utilized a similar classification for measuring the prevalence of kidney stones (Wang et al., 2022; Green et al., 2022).

Household Food Security. The primary exposure was household food security status, measured using the U.S. Food Security Survey Module questions. In the NHANES survey, participants were asked 18 questions (for households with children) and 10 questions (without children) about challenges associated with affording food in the past 12 months. Based on the household responses to the survey, overall food security is classified into four levels: (1) high food security, which indicates no reported difficulties with food access; (2) marginal food security, where households experience occasional concerns about food access or sufficiency but no significant changes in diet quality; (3) low food security, characterized by reduced quality, variety, or desirability of the diet are present without significant reduced food intake; and (4) very low food security, which suggests disruption in eating patterns and food intake due to the lack of access to food (United States Department of Agriculture Economic Research Service, 2025). In the current study, food security status was categorized as a binary variable: food secure (high or marginal food security) and food insecure (low or very low food security), to align with the primary aim and improve the robustness of models. This classification is also consistent with the United States Department of Agriculture (USDA) definitions and guidelines of food security status as well as prior studies using NHANES data (USDA Economic Research Service, n.d.; Seligman et al., 2010; Fleming et al., 2021; Wang et al., 2022).

Family Income Level. The association between food insecurity and nephrolithiasis was stratified by family income level, which was determined using the poverty-to-income ratio (PIR). NHANES reports PIR for each respondent, which is the ratio of total family income to the federal poverty threshold. For this analysis, PIR was categorized into three groups: low, middle, and high income. Low-income was defined as PIR < 1.30, middle-income as 1.30 to 3.49, and high-income as PIR> 3.5, corresponding to income levels of $<$130%, 130-349%, and $\geq$350% of the poverty line, respectively. The cutoffs are based on Supplemental Nutrition Assistance Program (SNAP) eligibility used in prior research (Ogden et al., 2010; Fadeyev et al., 2021).

Covariates. Several demographic, socioeconomic, lifestyle factors, and health-related variables were included as covariates for descriptive statistics. Demographic characteristics consisted of age, gender, race/ethnicity, marital status, family size, and number of children in the household. Socioeconomic characteristics include education level, receipt of food stamps or SNAP benefits, and health insurance coverage. Physical activity and smoking status are lifestyle factors associated with both food insecurity and nephrolithiasis risk (Huang et al., 2023; Mao et al., 2022; Chen et al., 2025; Sheira et al., 2021). Health indicators included obesity, hypertension, cholesterol, and diabetes. For the multivariate models, the following covariates were added as potential confounders: age, gender, race/ethnicity, education level, health insurance coverage, physical activity, smoking status, obesity, hypertension, cholesterol, and diabetes. These variables were selected based on theoretical considerations and prior studies that identified them as confounding variables (Wang et al., 2022; Stuff et al., 2007; Green et al., 2022).

Statistical Analysis

Because NHANES uses a complex survey design, all the analyses were adjusted for sampling weights, stratification, and clustering as appropriate to provide nationally representative estimates. Descriptive statistics were reported for the study participants, stratified by food security status and nephrolithiasis status. The continuous and categorical variables were described by weighted mean with standard error (SE) and unweighted frequency proportions with weighted column percentages (%), respectively. Multivariable logistic regression models were performed to estimate the adjusted odds ratios (AORs) and 95% confidence intervals (CIs) for the association between food insecurity and nephrolithiasis, controlling for selected confounding variables. To address the second aim of this study, stratified analyses were conducted by family income groups (low-, middle-, and high-income) to explore whether the relationship varied by family income level. Within each income stratum, separate logistic regression models were constructed, adjusting for the same confounding variables. Interaction between food insecurity and income level was also tested in the model by adding the cross-product term to assess their significance. Statistical significance was determined at the alpha level of 0.05. All analyses were conducted using SAS version 9.4.

Results

Sample Characteristics

16,418 participants were included in the study sample. Table 1 presents the baseline characteristics of respondents by household food security status. Approximately 22.4% were classified as food insecure. Compared to food secure individuals, those with food insecurity were younger (43.2 vs. 48.9 years), more likely to be female (54.7%), never married (23.4%), and had higher proportions of Non-Hispanic Black (16.8%), Mexican American (16.6%), or other Hispanic (11.2%). Food insecure groups also had lower educational attainment (27.9% vs. 10.6% completed less than high school), tend to have low income (62.6%), and lack health insurance (29.7%). Furthermore, those who were food insecure were more likely to be obese (28.5%), have hypertension (28.2%), and diabetes (12.8%), compared to food secure participants. Cigarette smoking is reported to be more common among food insecure respondents (33.7% vs. 15.4%); however, they reported more participation in physical activity (29.7% vs. 21.5%).

Table 1. Sample Characteristics of the Study Population by Household Food Security Status, National Health and Nutrition Examination Survey, 2013-2018 (N = 16,418)*

Characteristics	Total (N = 16418) N (%)	Food Secure (N = 12746) N (%)	Food Insecure (N = 3672) N (%)
Age, mean (SE)	47.9 (0.3)	48.9 (0.3)	43.2 (0.5)
Gender			
Female	8531 (52)	6564 (51.5)	1967 (54.7)
Male	7887 (48)	6182 (48.5)	1705 (45.3)
Race & Ethnicity			
Non-Hispanic White	6115 (64.4)	5033 (67.8)	1082 (47.7)
Non-Hispanic Black	3540 (11.4)	2645 (10.3)	895 (16.8)
Non-Hispanic Asian	2045 (5.5)	1870 (6.2)	175 (2.6)
Mexican American	2397 (8.9)	1599 (7.3)	798 (16.6)
Other Hispanic	1691 (6.2)	1146 (5.1)	545 (11.2)
Other Race	630 (3.7)	453 (3.4)	177 (5.2)
Education level			
Less than high school	3561 (13.5)	2251 (10.6)	1310 (27.9)
High school graduate or GED	3742 (23.4)	2798 (22.2)	944 (29.4)
Some college or AA degree	5053 (31.9)	3942 (31.5)	1111 (33.8)
College graduate or above	4043 (31.2)	3744 (35.7)	299 (9)

Characteristics	Total (N = 16418) N (%)	Food Secure (N = 12746) N (%)	Food Insecure (N = 3672) N (%)
Marital status			
Married	8276 (54.2)	6850 (57.5)	1426 (37.9)
Widowed	1264 (5.8)	1005 (5.9)	259 (5.4)
Divorced	1861 (10.4)	1352 (9.8)	509 (13.5)
Separated	548 (2.4)	330 (1.8)	218 (5.5)
Never married	3021 (18.4)	2218 (17.4)	803 (23.4)
Living with partner	1440 (8.7)	987 (7.6)	453 (14.3)
Family size			
Less than 3 people	10492 (67.3)	8425 (69.3)	2067 (57.9)
4 to 6 people	5146 (29.5)	3840 (28.3)	1306 (35.6)
7 or more people	780 (3.1)	481 (2.4)	299 (6.5)
Number of children in the household			
No children	13154 (81.8)	10402 (83.5)	2752 (73.2)
1 children	2192 (12.3)	1591 (11.1)	601 (18.1)
2 or more children	1072 (5.9)	753 (5.3)	319 (8.8)
Family Income to Poverty Ratio (PIR)[a]			
Low-income (PIR < 1.3)	7093 (32.4)	4576 (26.2)	2517 (62.6)
Middle-income (PIR > 1.3-3.5)	5734 (32.7)	4695 (35.1)	1039 (32.8)
High-income (PIR > 3.5)	3591 (32.8)	3475 (38.7)	116 (4.6)
Health insurance coverage			
Yes	13480 (85.1)	10899 (88.1)	2581 (70.3)
No	2909 (14.9)	1828 (11.9)	1081 (29.7)
Obesity[b]			
Yes	4111 (25.5)	3097 (25)	1014 (28.5)
No	12307 (74.5)	9649 (75.1)	2658 (71.5)
Hypertension[c]			
Yes	4900 (26.8)	3758 (26.5)	1142 (28.2)
No	11469 (73.2)	8951 (73.5)	2518 (71.8)
High cholesterol[d]			
Yes	5690 (33.9)	4524 (35)	1166 (28.3)
No	10619 (66.1)	8149 (65)	2470 (71.7)
Diabetes[e]			
Yes	2336 (11)	1724 (10.7)	612 (12.8)

Characteristics	Total (N = 16418) N (%)	Food Secure (N = 12746) N (%)	Food Insecure (N = 3672) N (%)
No	13611 (88.9)	10656 (89.3)	2955 (87.2)
Physical activity[f]			
Yes	3407 (22.9)	2456 (21.5)	951 (29.7)
No	13003 (77.1)	10284 (78.5)	2719 (70.3)
Cigarette smoking status[g]			
Current smoker	3130 (18.6)	2030 (15.4)	1100 (33.7)
Former smoker	3863 (24.6)	3124 (25.7)	739 (19.4)
Never smoked	9413 (56.8)	7583 (58.9)	1830 (46.9)

*Note: The values are presented as weighted means (SE) or unweighted frequency counts (weighted column %).

[a] Obesity defined as a body mass index (BMI) of at least 30 kg/m^2

[b] Family Income to Poverty Ratio (PIR):

PIR < 1.3 refers to family income less than 1.3 times the poverty level;
PIR between 1.3 and 3.5 refers to family income of 1.3 to 3.5 times the poverty level;
PIR > 3.5 refers to family income greater than 3.5 times the poverty level.

[c] Hypertension defined as self-reported physician diagnosis of high blood pressure (ever and two times).

[d] High cholesterol defined as a self-reported physician diagnosis of high blood cholesterol.

[e] Diabetes defined as self-reported physician diagnosis of diabetes or sugar diabetes.

[f] Physical activity defined based on self-reported reponses to participation in work-related vigorous activities lasting at least 10 minutes.

[g] Current smoker defined as ever smoking 100 cigarettes and now smoking every day or some days; Former smoker defined as ever smoking 100 cigarettes and not currently smoking; Never smoked defined as never smoking cigarettes.

Table 2. Sample Characteristics of the Study Population by Nephrolithiasis Status, National Health and Nutrition Examination Survey, 2013-2018 (N = 16,418)*

Characteristics	Total (N = 16418) N (%)	History of Nephrolithiasis[a] (N = 1648) N (%)	No History of Nephrolithiasis (N = 14770) N (%)
Age, mean (SE)		47.3 (0.3)	53.2 (0.5)
Gender			
Female	8531 (52)	768 (46.5)	7763 (52.7)
Male	7887 (48)	880 (53.5)	7007 (47.3)
Race & Ethnicity			
Non-Hispanic White	6115 (64.4)	826 (74.2)	5289 (63.2)
Non-Hispanic Black	3540 (11.4)	239 (6.8)	3301 (11.9)
Non-Hispanic Asian	2045 (5.5)	119 (2.8)	1926 (5.9)
Mexican American	2397 (8.9)	208 (6.3)	2189 (9.2)
Other Hispanic	1691 (6.2)	186 (5.6)	1505 (6.2)
Other Race	630 (3.7)	70 (4.4)	560 (3.6)
Education level			
Less than high school	3561 (13.5)	370 (13.7)	3191 (13.5)
High school graduate or GED	3742 (23.4)	358 (22.2)	3384 (23.6)
Some college or AA degree	5053 (31.9)	562 (33.5)	4491 (31.7)
College graduate or above	4043 (31.2)	356 (30.6)	3687 (31.2)
Marital status			
Married	8276 (54.2)	903 (60.7)	7373 (53.4)
Widowed	1264 (5.8)	145 (6.1)	1119 (5.8)
Divorced	1861 (10.4)	232 (13.2)	1629 (10.1)
Separated	548 (2.4)	59 (2.3)	489 (2.5)
Never married	3021 (18.4)	185 (10.6)	2836 (19.4)
Living with partner	1440 (8.7)	123 (7.1)	1317 (8.9)
Family size			
Less than 3 people	10492 (67.3)	1086 (68.6)	9406 (67.2)
4 to 6 people	5146 (29.5)	491 (28.3)	4655 (29.7)
7 or more people	780 (3.1)	71 (3.1)	709 (3.2)
Number of children in the household			
No children	13154 (81.8)	1400 (86.6)	11754 (81.2)
1 children	2192 (12.3)	175 (9.4)	2017 (12.7)

Characteristics	Total (N = 16418) N (%)	History of Nephrolithiasis[a] (N = 1648) N (%)	No History of Nephrolithiasis (N = 14770) N (%)
2 or more children	1072 (5.9)	73 (4)	999 (6.2)
Family Income to Poverty Ratio (PIR)[a]			
Low-income (PIR < 1.3)	7093 (32.4)	672 (28.9)	6421 (32.9)
Middle-income (PIR > 1.3-3.5)	5734 (32.7)	608 (35.9)	5126 (34.6)
High-income (PIR > 3.5)	3591 (32.8)	368 (35.3)	3223 (32.5)
Health insurance coverage			
Yes	13480 (85.1)	1427 (89.5)	12053 (84.5)
No	2909 (14.9)	218 (10.5)	2691 (15.5)
Obesity[b]			
Yes	4111 (25.5)	503 (31.9)	3608 (24.8)
No	12307 (74.5)	1145 (68.1)	11162 (75.2)
Hypertension[c]			
Yes	4900 (26.8)	716 (41.5)	4184 (25)
No	11469 (73.2)	931 (58.5)	10538 (75)
High cholesterol[d]			
Yes	5690 (33.9)	747 (45.9)	4943 (32.4)
No	10619 (66.1)	884 (54.1)	9735 (67.6)
Diabetes[e]			
Yes	2336 (11)	392 (20)	1944 (10)
No	13611 (88.9)	1194 (80)	12417 (90)
Physical activity[f]			
Yes	3407 (22.9)	365 (25.9)	3042 (22.6)
No	13003 (77.1)	1282 (74.1)	11721 (77.4)
Cigarette smoking status[g]			
Current smoker	3130 (18.6)	335 (18.5)	2795 (18.6)
Former smoker	3863 (24.6)	494 (30.4)	3369 (23.9)
Never smoked	9413 (56.8)	818 (51.1)	8595 (57.5)

*Note: The values are presented as weighted means (SE) or unweighted frequency counts (weighted column %).

[a]Nephrolithiasis defined as self-reported responses to ever having kidney stones.

In Table 2, the baseline sample characteristics were stratified by nephrolithiasis status. Respondents with a history of nephrolithiasis were older on average (53.2 years), and more likely to be male (53.5%) and Non-Hispanic White (74.2%). Compared to those without a history of nephrolithiasis, participants with nephrolithiasis had higher prevalences of obesity (31.9%), hypertension (41.5%), high cholesterol (45.9%), and diabetes (20%).

In examining the association between food insecurity and nephrolithiasis (Table 3), individuals with food insecurity had significantly higher odds of kidney stones compared to food secure participants, after adjusting for confounders (AOR: 1.32; 95% CI: 1.12, 1.57). The multivariate analysis was stratified by family income level, as shown in Table 4. Among the individuals with a low family income, food insecurity was significantly associated with increased odds of kidney stones compared to those who were food secure (AOR: 1.27; 95% CI: 1.02, 1.57). In the middle-income group, food insecurity was similarly associated with higher odds of nephrolithiasis risk (AOR: 1.50; 95% CI: 1.17, 1.93). The association between food insecurity and nephrolithiasis among the high-income participants, however, was not statistically significant (AOR: 1.20; 95% CI: 0.57, 2.55). The testing of the interaction between food security status and family income level did not yield significant significance (p = 0.8773).

Table 3. Association Between Household Food Insecurity and Nephrolithiasis Among US Adults, National Health and Nutrition Examination Survey, 2013-2018 (N = 16,418)

	Nephrolithiasis Prevalence N (%)	**OR (95% CI)**	**AOR[a] (95% CI)**
Food Secure	1242 (75.4)	Ref	Ref
Food Insecure	406 (24.6)	1.14 (0.98, 1.31)	1.32 (1.12, 1.57)

[a] Adjusted Odds Ratio; adjusted for age, gender, race, physical activity, smoking status, obesity, hypertension, cholesterol, diabetes

Table 4. Association Between Household Food Insecurity and Nephrolithiasis Among US Adults By Family Income to Poverty Ratio Levels, National Health and Nutrition Examination Survey 2013-2018 (N = 16,418)

	OR (95% CI)	AOR[a] (95% CI)
Low-Income (PIR <1.3)		
Food secure	Ref	Ref
Food insecure	1.21 (0.98, 1.149)	1.27 (1.02, 1.57)
Middle-Income (PIR > 1.3 - 3.5)		
Food secure	Ref	Ref
Food insecure	1.37 (1.09, 1.71)	1.5 (1.17, 1.93)
High-Income (PIR > 3.5)		
Food secure	Ref	Ref
Food insecure	1.01 (0.48, 2.16)	1.2 (0.57, 2.55)

Notes: CI, Confidence Interval; OR, Odds Ratio
[a] Adjusted Odds Ratio; adjusted for age, gender, race, physical activity, smoking status, obesity, hypertension, cholesterol, diabetes

Discussion

This study aimed to examine the association between household food insecurity and nephrolithiasis among U.S. adults, and whether this association differed across family income levels. Based on the findings, food insecurity was significantly associated with increased likelihood of nephrolithiasis among individuals with low and middle family incomes. While the interaction between food security status and family income level was not statistically significant, stratified analyses were still performed to explore potential differences across income groups. Food insecurity is more prevalent among individuals with lower socioeconomic status, resulting in dietary patterns that may increase the risk of nephrolithiasis, which is also more common among lower-income adults (Leung et al., 2014; Scotland et al., 2022). Previous research identified food insecurity as a risk factor for kidney stones (Wang et al., 2022; Green et al., 2022), supporting the findings of the current study; particularly, a significantly positive association was found among low- and middle-income groups. This may highlight disparities in diet quality and nutritional resources that disproportionately affect these populations.

In the current study, individuals who experienced food insecurity had 27% higher odds of kidney stones among low-income groups; however, the middle-income group with food insecurity showed a 50% increase in odds, indicating a gradient effect across income levels. Given its strong association with income, food has been historically more common among low-income communities (Jones et al., 2013); however, increased food insecurity prevalence and decreased food expenditures have been found among middle-income populations in recent years (Nord, 2009). In 2023, approximately 21% of food insecure US households reported an annual income of greater than $75,000, a 3% increase from 2022 (Rabbitt et al., 2023; Rabbitt et al., 2024). Food insecurity could have different implications across the income groups. For low-income populations, food insecurity is primarily driven by factors such as financial constraints, economic hardship, and limited physical access to nutritious food (Gundersen et al., 2011). They are more likely to be qualified for nutritional assistance programs, such as SNAP or Special Supplemental Nutrition Program for Women, Infants, and Children (WIC), aimed at reducing barriers to food access. In contrast, food insecurity among middle-income populations could be influenced by unexpected economic stressors, such as inflation and loss of employment (Gundersen et al., 2011).

Food insecurity as a risk factor for nephrolithiasis can be explained by several factors or mechanisms. Diets rich in a variety of nutritious fruits and vegetables are essential for the management and prevention of kidney stone formation (Nirumand et al., 2018). Compared to those who are food secure, food insecure individuals are more likely to consume less fruits, vegetables, and micronutrients, which are typically more expensive to purchase (Drewnowksi & Specter, 2004). High fructose intake has been linked to increased uric acid levels and insulin resistance, further contributing to kidney stone formation (Taylor et al., 2004); however, consumption of sugar-sweetened beverages remains high among food insecure groups. Furthermore, chronic conditions such as hypertension, diabetes, obesity, are more prevalent among food insecure populations, which also elevates the risk of nephrolithiasis (Scales et al., 2012).

This study has several strengths. A large, nationally representative dataset with standard measures was utilized, which ensures generalizability of the results to the US adult population. The use of NHANES data allows controlling for a wide range of confounding factors and takes the complex survey design into account for the analysis, which yields nationally representative estimates. In addition, the association between food insecurity and nephrolithiasis was stratified by income level, which was not previously examined, and future research can build on the findings from this study to further examine social determinants of kidney stones. However, there are also limitations to be noted. Due to the nature of the cross-sectional study, temporality and causality cannot be determined. Food insecurity was measured in the past 12 months, while kidney stone history was assessed as ever/never response; hence, it is possible that some participants could have developed kidney stones before they experienced food insecurity, which may fail to confirm that food insecurity preceded kidney stone formation. The current study suggests the presence of an association, but prospective cohort studies are more helpful for establishing causal relationships; future research can consider this design to determine causality. Additionally, the outcome was measured based on a self-reported questionnaire, which could result in bias if potential misclassification was present, depending on whether the participant forgot a past kidney stone diagnosis or reported having a kidney stone when it could have been another urinary issue. However, similar measure was used in prior research, confirming validity of this self-reported questionnaire (Wang et al., 2022; Abufaraj et al., 2022). Furthermore, although important confounders were identified and controlled for in the analysis, variables such as dietary factors, which are associated with both the exposure and outcome, were not included in the models to avoid potential collinearity with food insecurity, as it directly influences diet. Finally, while the stratified analysis by income level provided valuable insights, it led to smaller subgroup sample sizes, particularly in the high-income food insecure groups. The lack of a significant interaction between food insecurity and income could imply that there is no difference by income, so it could be a confounding variable. Stratified analyses were still conducted based on theoretical and conceptual considerations as well as observed differences in OR estimates across the income strata; however, these results should be interpreted with caution.

Overall, the current study found a positive association between food insecurity and nephrolithiasis in US adults. Those with food insecurity, especially in low- and middle-income brackets, had increased odds of nephrolithiasis, after accounting for demographic and health-related factors. The findings suggest that mitigating food insecurity, such as improving the accessibility and quality of food, through public policy efforts is crucial to the prevention and management of nephrolithiasis.

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