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# Dietary Habits, Poverty, and Chronic Kidney Disease in an Urban Population

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## Abstract

**Background—**Poverty is associated with chronic kidney disease (CKD) in the US and worldwide. Poor dietary habits may contribute to this disparity.

**Study Design—**Cross-sectional study.

**Setting & Participants—**2,058 community-dwelling adults aged 30-64 years residing in Baltimore City, Maryland.

**Predictors—**Adherence to the Dietary Approaches to Stop Hypertension (DASH) diet. DASH scoring based on 9 target nutrients (total fat, saturated fat, protein, fiber, cholesterol, calcium, magnesium, sodium, and potassium); adherence defined as score ≥4.5 out of maximum possible

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score of 9. Poverty (self-reported household income <125% of 2004 Department of Health and Human Services guideline) and non-poverty (≥125% of guideline).

**Outcomes & Measurements—**CKD defined as estimated glomerular filtration rate <60mL/min/1.73m$^2$ (CKD-EPI). Multivariable logistic regression used to calculate adjusted odds ratios (AORs) for relation of DASH score tertile and CKD, stratified by poverty status.

**Results—**Among 2,058 participants (mean age 48 years; 57% black; 44% male; 42% with poverty), median DASH score was low, 1.5 (IQR, 1-2.5). Only 5.4% were adherent. Poverty, male sex, black race, and smoking were more prevalent among the lower DASH score tertiles, while higher education and regular health care were more prevalent among the highest DASH score tertile (P<0.05 for all). Fiber, calcium, magnesium and potassium intake were lower, and cholesterol higher, among the poverty as compared to non-poverty group (P<0.05 for all), with no difference in sodium intake. A total of 5.6% of the poverty and 3.8% of the non-poverty group had CKD (P=0.05). The lowest DASH tertile (compared to the highest) was associated with more CKD among the poverty [AOR 3.15, 95% Confidence Interval (CI) 1.51-6.56], but not among the non-poverty group (AOR 0.73, 95% CI 0.37-1.43). P interaction 0.001.

**Conclusions—**Poor dietary habits are strongly associated with CKD among the urban poor and may represent a target for interventions aimed at reducing disparities in CKD.

### Keywords

HANDLS; socioeconomic status; diet; renal; disparity; epidemiology

## INTRODUCTION

Poverty is associated with multiple adverse chronic kidney disease (CKD) outcomes, including reduced kidney function[1-3], albuminuria[4,5] and increased risk of end-stage renal disease (ESRD)[6,7]. Poor dietary habits due to limited access to healthy foods could be a contributor. For example, food insecurity, a risk factor for CKD[8], affects approximately 25% of low-income adults in the US[9] and is associated with increased intake of energy-dense foods and limited fruit and vegetable intake[10,11]. Fresh fruits and vegetables are often not readily available in low-income communities[12,13], and if available they are expensive compared to other foods[13,14]. Thus, poverty may pose a significant challenge for individuals seeking to follow a healthy dietary pattern.

The Dietary Approaches to Stop Hypertension (DASH) diet is a dietary pattern high in fruits and vegetables, moderate in low-fat dairy products, and low in animal protein, but with substantial amounts of plant protein from legumes and nuts[15]. In addition to its favorable effects on blood pressure[15], adherence to the DASH diet has been associated with better health, including lower risk of hypertension[16], type 2 diabetes[17], heart disease and stroke[18]. Further, DASH diet adherence has been associated with lower risk of eGFR decline[19]. However, little is known about the relation of DASH diet adherence to disparities in CKD.

To inform future efforts to mitigate socioeconomic disparities in CKD through tailored interventions and public policy changes, we sought to determine whether DASH diet

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adherence differs between adults living in poverty versus non-poverty and to determine if the relation of DASH diet adherence to CKD differed between these populations.

# METHODS

## Study 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 socioeconomic status (SES) on the development of cardiovascular and cerebrovascular health disparities among minority and lower SES subgroups. Participants are community-dwelling blacks and whites age 30-64 years at enrollment, drawn from 13 neighborhoods, each of which composed of contiguous U.S. census tracts in Baltimore City, Maryland that reflect socioeconomic and racial diversity. Participants were sampled representatively using a heuristic study design, which was a factorial cross of four factors (age, gender, race and SES) with approximately equal numbers of participants per "cell". Individuals who self-identified with neither black nor white race were excluded from the study. Household enrollment was from August 2004 to November 2008. Each participant provided written informed consent. The National Institute of Environmental Health Sciences, National Institutes of Health, approved the study protocol.[20]

The total HANDLS Study population is 3,720. For the purposes of this study, we limited our sample to those participants with baseline serum creatinine and two 24-hour food intake measurements (N=2,058). Compared to excluded participants, those in our sample were of similar age (47.9 versus 47.6 years) and poverty status (42.2 versus 40.1%); P>0.05 for both. However, included persons were less likely to be male (43.6 versus 47.6%; P 0.015) and less likely to be black (57.0 versus 61.7%; P 0.004) than those excluded.

## Measurements

**Independent Variables—**The independent variables of interest were poverty status and DASH diet adherence. Poverty was chosen as the measure of SES in the HANDLS study to allow ease of selection of a representative sample. Poverty was defined as a self-reported annual household income below 125% of the 2004 Department of Health and Human Services poverty guideline (family of 4 earning <$23,562).[21] Non-poverty was defined as the converse. Poverty status was determined at the doorstep during household enrollment based on several screening questions, including "how many people are in your household?" and "is your family income above or below this cutoff?". This cutoff value for poverty was selected by a panel of experts and has been used in initiatives such as the National School Lunch Program.[22] DASH diet adherence was defined using 24-hour food intake information gathered using the US Department of Agriculture's Automated Multiple Pass Method (AMPM), Versions 2.3 - 2.6, a computerized methodology, on 2 separated days separated by 7-10 days.[23] This method was supplemented by measurement aids, such as measuring cups, spoons, a ruler, and an illustrated Food Model Booklet to assist participants in estimating accurate quantities of foods and beverages consumed. Both dietary recalls were administered in-person by trained interviewers. The AMPM was validated in a study with

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524 healthy, weight-stable volunteers, aged 30-69 years, as well as studies with 20 adult women and 12 adult men.[23,24] The method is effective for collecting accurate group energy intake of adults, based on comparisons of reported energy intake to total energy expenditure using the doubly labeled water technique.[23-25] The dietary recalls were coded using Survey Net, matching foods consumed with codes in the Food and Nutrient Database for Dietary Studies (FNDDS), Version 3. Energy and selected nutrient intakes were calculated for each recall day.[26] There were no significant differences in energy or nutrient intakes between the first and second recall days. The recalls represented both weekend and weekday consumption patterns and no differences existed between energy and nutrient intakes by day of the week. For this study, the mean nutrient values were used to assess adherence to the DASH diet. Individuals who reported no foods or reported fasting were not included in the analysis.

A DASH diet adherence score was calculated for each participant based on nutrient targets for the DASH dietary pattern as reported by Mellen *et al*.[27] There were 9 target nutrients, namely protein, total fat, saturated fat, cholesterol, fiber, magnesium, calcium, potassium, and sodium, used to calculate the total score (a maximum of 9). Individuals who met the DASH target for a nutrient received a score of 1 while those who achieved the intermediate target for a nutrient received a score of 0.5. (**Table 1**)

**Dependent Variable—**The dependent variable was CKD, and was determined using single laboratory measures of serum creatinine (n= 2,058) and urine microalbumin (n=1,294) concentrations. Serum creatinine was measured for 8% of participants at the NIA Clinical Research Branch Core Laboratory using a modified kinetic Jaffe method (CREA method, Dade Dimension X-Pand Clinical Chemistry System, Siemens Healthcare Diagnostics Inc., Newark, DE); and was measured for the remainder of participants at Quest Diagnostics, Inc. by isotope dilution mass spectrometry (Olympus America Inc., Melville, NY) and standardized to the reference laboratory at the Cleveland Clinic. For all participants, urine microalbumin concentration was measured at Quest Diagnostics, Inc. using an immunoturbimetric assay (Kamiya Biomedical Co., Seattle, WA). CKD was defined as an estimated glomerular filtration rate (eGFR) <60 mL/min per 1.73 $m^2$ calculated using the CKD Epidemiology Collaboration creatinine-based equation[28].

**Covariates—**Race was self-reported (black or white) during the initial household survey. Individuals identifying themselves as multi-ethnic were included in the racial group with which they most strongly identified, and those identifying with neither black nor white race were not eligible for the study. Additional demographic data including, age, sex, marital status, health insurance status, and educational history were also assessed during an initial household survey. A mobile research vehicle (MRV) was the site of health care provider ascertained medical history, substance use history and physical examination. Additionally, health care utilization was assessed on the MRV. Fasting venous blood specimen and spot urine samples were also collected on the MRV and analyzed at the NIA Clinical Research Branch Core Laboratory (Baltimore, MD) and Quest Diagnostics, Inc. (Baltimore, MD and Chantilly, VA).

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The presence of relevant comorbid diseases was ascertained via medical history, physical examination and laboratory assessment. Each participant underwent sitting and standing blood pressure measurements on each arm using the brachial artery auscultation method with an inflatable cuff of appropriate size[8]. Hypertension was defined as an average of seated and standing systolic blood pressure ≥ 140 mmHg, an average of seated and standing diastolic blood pressure ≥ 90 mmHg[29], a history of blood pressure medication use, or a self-report of hypertension. Diabetes mellitus was defined as a fasting plasma glucose concentration of ≥ 126 mg/dl (7.0 mmol/l)[30] or self-report of diabetes. Anthropometric measures were performed, including height and weight, and were used to calculate body mass index (BMI) to determine the presence of obesity (defined as a BMI ≥30 kg/$m^2$). Tobacco use was defined as a report of at least 100 cigarettes smoked in the participant's lifetime.

## Statistical Analysis

Participant characteristics stratified by poverty status and DASH diet adherence were compared using Fisher's exact tests or analysis of variance for categorical variables and *t* tests for continuous variables. Descriptive statistics and Fisher's exact tests were used to compare the unadjusted prevalence of CKD by poverty status and DASH diet adherence. Multivariable logistic regression was performed to determine the presence, direction, magnitude, and independence of the association between DASH diet adherence and prevalent CKD, stratified by poverty status. An interaction term between DASH diet adherence and poverty status was examined in an overall regression model (with CKD as the outcome) to test for effect modification. Potential confounders considered were factors found to be associated with poverty and/or CKD in previous studies. Confounders included in the multivariable models were age, race, gender, education, regular health care provider, diabetes, hypertension, tobacco use and average daily energy intake. Other variables examined (insurance status, obesity, systolic blood pressure and fasting serum glucose) are reported in our descriptive analysis, but were not included in our multivariable models to avoid model over-fitting.

Three sensitivity analyses were performed to test our findings. First, CKD was re-defined as the presence of an eGFR <60 mL/min per 1.73 $m^2$ or urinary microalbumin >= 30 mg/g creatinine (n for analysis=1,294). Second, we examined potential effect modification by race given prior studies showing that poverty may have a differential relation with prevalent CKD across racial groups[1,4,5] and a prior report that African Americans derive greater blood pressure lowering effects from the DASH diet than do whites[31]. Thus, we included interaction terms for race x poverty status and race x DASH diet adherence tertile in minimally adjusted models (including age, sex, and the interacting variables). Third, given that only those participants who had laboratory measures performed at Quest Diagnostics, Inc. underwent standardized serum creatinine measures, analyses were performed restricted to these participants.

In all analyses, the possibility of confounding by U.S. census tract was controlled with fixed-effects modeling, clustered on neighborhood.[30] A two-sided $P$ <0.05 was used as the

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level of significance for all tests. Statistical analyses were performed using Stata software, version 11 (StataCorp, College Station, TX).

## RESULTS

### Participant Characteristics and DASH Diet Adherence

A total of 869 (42.2%) participants met criteria for poverty status. (**Table 2**) These participants were less likely to be male and more likely to be of black race as compared to the non-poverty participants. The poverty group also completed fewer years of education, and when compared to the non-poverty group, were more likely to report a lack of a regular health care provider and/or a lack of health insurance. Hypertension and tobacco use were more common among the poverty group, however, there were no differences in prevalence of diabetes or obesity, or in average daily energy intake between the two groups.

DASH diet adherence in this cohort was minimal, with only 4.5% of the poverty group, and 6.1% of the non-poverty group reporting dietary patterns consistent with the DASH diet (P= 0.1) (**Table 3**). There was a small, but statistically significant difference in total DASH score between the groups, with the poverty group having the lowest score. Nutrient intakes differed across the two groups, with the poverty group having higher cholesterol and lower fiber, magnesium, calcium and potassium intake than the non-poverty group (P <0.001 for all). Notably, saturated fat and sodium intake did not differ between the groups. Examination of participant characteristics across tertiles of DASH diet adherence (lowest, middle and highest adherence as determined by DASH score) revealed that male sex, black race, poverty, fewer years of education, lack of a regular health care provider, higher systolic blood pressure, tobacco use and greater daily energy intake were each more prevalent among the lower DASH diet adherence tertiles than the highest tertile (P<0.05 for all). (**Table 4**).

### Prevalence of CKD by DASH Diet Adherence and Poverty Status

A total of 94 (4.6%) participants had CKD, based on our primary definition of eGFR <60 ml/min per 1.73m$^2$, including 5.6% of the poverty and 3.8% of the non-poverty group (P=0.05). In univariate analyses, among the poverty group, DASH adherence tertile was inversely associated with CKD prevalence, with the highest tertile having the lowest prevalence of CKD at only 2.3% (P for trend 0.02). However, among the non-poverty group, there was no statistically significant relation between DASH adherence tertile and CKD. (**Figure 1**)

In logistic regression models, we first confirmed that poverty was associated with CKD in an age and race adjusted model, as previously reported in this cohort[1] [odds ratio (OR) 1.60, 95% Confidence Interval (CI) 1.02-2.49, comparing the poverty to non-poverty groups]. Adjustment for DASH adherence (by tertiles) in this model slightly attenuated the OR to 1.57, 95% CI 1.00-2.45. An interaction term for poverty status and DASH adherence tertile was significant (P interaction <0.001) and its inclusion to the aforementioned model reduced the OR for CKD comparing poverty to non-poverty groups to 0.69, 95% CI 0.37-1.29, therefore we proceeded with stratified models.

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In models stratified by poverty status, lesser adherence to the DASH diet was associated with greater odds of CKD only among the poverty group, where statistically significant trends across DASH score tertiles were observed (**Table 5)**. In a fully adjusted model, the lowest DASH score tertile (as compared to the highest) was associated with CKD among the poverty (OR 3.15, 95% CI 1.51-6.56), but not the non-poverty group (OR 0.73, 95% CI 0.37-1.43). The P interaction for poverty status and DASH tertile was 0.001.

### Sensitivity Analyses

When we defined CKD by both eGFR and albuminuria, results were similar to our primary definition of CKD (eGFR< 60 ml/min per 1.73m$^2$). Lesser DASH diet adherence was significantly associated with CKD only among individuals living in poverty, as opposed to the non-poverty group (p interaction for DASH diet adherence and poverty= <0.001 in our fully adjusted model. Inclusion of interaction terms for race x poverty status (which was statistically significant, as in our prior study[1]) and race x DASH adherence tertile (which was not statistically significant) to minimally adjusted models revealed results consistent with our primary analysis (p interaction for DASH diet adherence and poverty= <0.001). Among participants who underwent standardized serum creatinine measures, results were similar to our primary analysis (data not shown).

## DISCUSSION

Among urban adults, we found that adherence to a DASH dietary pattern was low, particularly among individuals living in poverty. Intake of specific nutrients also differed across poverty status, with poor individuals showing the least favorable profiles. The least DASH diet adherence was associated with CKD only among individuals living in poverty; and this finding persisted following consideration of multiple factors related to both diet and CKD, including blood pressure and glucose intolerance, as well as potential variations of this association across racial groups.

To our knowledge, this is the first report comparing dietary patterns in the context of socioeconomic disparities in CKD. In our study, participants living in poverty consumed diets lower in several potentially renal-protective nutrients than consumed by the non-poverty participants, including potassium. Hypokalemia was recently reported to be associated with increased risk of CKD progression[32], and its postulated effects on CKD progression may relate to dietary acid load. Rich in potassium, the DASH diet has an estimated potential renal acid load of -25.5mEq/day[33] as compared to 50-75 mEq/day, which has been reported in several general populations[34-37]. Studies in both animals and humans suggest that lowering the dietary acid load can slow decline of GFR[38-40], presumably through its influence on lowering complement activation and reducing pro-fibrotic factors such as angiotensin II, endothelin-1 and aldosterone[33,41,42].

Our observation of a differential relation of DASH diet adherence and CKD across poverty groups deserves comment. There are several possible explanations for this finding, including the possibility that the reasons for following (or not following) a DASH-style diet may have differed across the two groups in ways not measured in our study. Notwithstanding the possibility of these unmeasured confounders, it is conceivable that following a healthful

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dietary pattern such as the DASH diet could portend greater incremental benefit for economically disadvantaged individuals than for wealthier persons. Access to high quality health care[43] and safe places for recreation[44] are often limited for persons living in poverty, and stressors such as discrimination[45] and housing insecurity[46] are more prevalent. Therefore, if an individual living under these circumstances is somehow able to follow a healthful diet, it is conceivable that they may derive more benefit from it than a person following a similar diet, but who has few social limitations. If verified in other studies, this concept argues strongly for greater public policy emphasis on improving the diets of disadvantaged persons as a means to eliminate disparities in health.

Our study had limitations that should be considered. First, because of its cross-sectional design, a direct causal relationship between DASH diet adherence and CKD cannot be inferred and reverse causality (e.g. a diagnosis of CKD leading to greater or lesser adherence to a DASH-style diet) is possible. Unmeasured confounders of this association are also possible. For example, our study lacked data on food additives and nutritional supplements consumed by participants, and some have been associated with CKD in previous studies[47,48]. Additionally, we lacked a measure of physical activity which often correlates with dietary practices[49] and has been associated with CKD outcomes[50]. Second, there is always some degree of error associated with the measurement of food consumption despite the validity of USDA's automated multiple pass method (AMPM) in both normal and overweight/obese individuals. Energy intake measured by the AMPM compared to total energy expenditure measured by the doubly labeled water technique has been reported to underreport energy intake by 11% overall, by less than 3% for normal weight subjects with body mass index (BMI) $< 25$ m$^2$/kg and 16% for overweight subjects with BMI $\geq 25$ m$^2$/kg.[23] For groups the absolute nutrient intakes derived from two recalls using AMPM are considered accurate. For nutrients consumed nearly daily by most people, such as fats or carbohydrates, two 24-hr recalls should yield true assessments of individual nutrient intakes. However categorizing true mean individual intakes needs more than two recalls to capture intake of episodically consumed foods rich in selected nutrients such as dark orange or green vegetables and omega-3 rich fish. The number of days required depends upon the nutrient given the ratio of coefficient of variations of inter- to intra-variations associated with 24-hour dietary recalls is nutrient specific.[51] The expression of vitamins and minerals per 1,000 kcal, as done in our study, minimizes these variations. Given the time required to complete all the assessments included in the HANDLS study, only 2 recalls were performed to reduce respondent burden. These issues should be kept in mind when drawing inferences from our study and call for future large population based studies with efficient and in-depth dietary assessment measures. Third, our findings may not be generalizable to non-urban populations where the types of foods available (e.g. less access to ‘fast foods’ in rural areas[52]) may differ. Fourth, the use of income as a measure of poverty status and SES in our study may have not fully captured other elements of socioeconomic position such as education, employment status, occupation, or wealth. Finally, the overall low prevalence of CKD in this population may have influenced our results, and future analyses of socioeconomically diverse cohorts with greater burden of CKD are therefore encouraged.

Despite its limitations, our findings call for longitudinal controlled and interventional studies investigating the role of diet in socioeconomic disparities in CKD. Healthy People 2020, the

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U.S. national blueprint for public health goals, aims to eliminate socioeconomic health disparities among patients with kidney disease in the U.S. by 2020. Elucidating the role of dietary patterns such as the DASH diet in these disparities may prove beneficial in efforts to achieve this goal. On the individual patient-level, as clinicians aim to advise patients of their CKD risk and develop tailored management plans, it may be important to assess potential economic barriers (e.g. food insecurity[8]) to following healthful dietary patterns such as the DASH diet.

In conclusion, poor dietary habits are common among the urban poor and are strongly associated with their greater prevalence of CKD. Thus, dietary habits may represent a target for interventions aimed at reducing disparities in CKD.

## PRACTICAL APPLICATION

Adherence to a DASH dietary pattern is uncommon among urban-dwelling adults. Low DASH diet adherence is associated with CKD, especially among individuals living in poverty.

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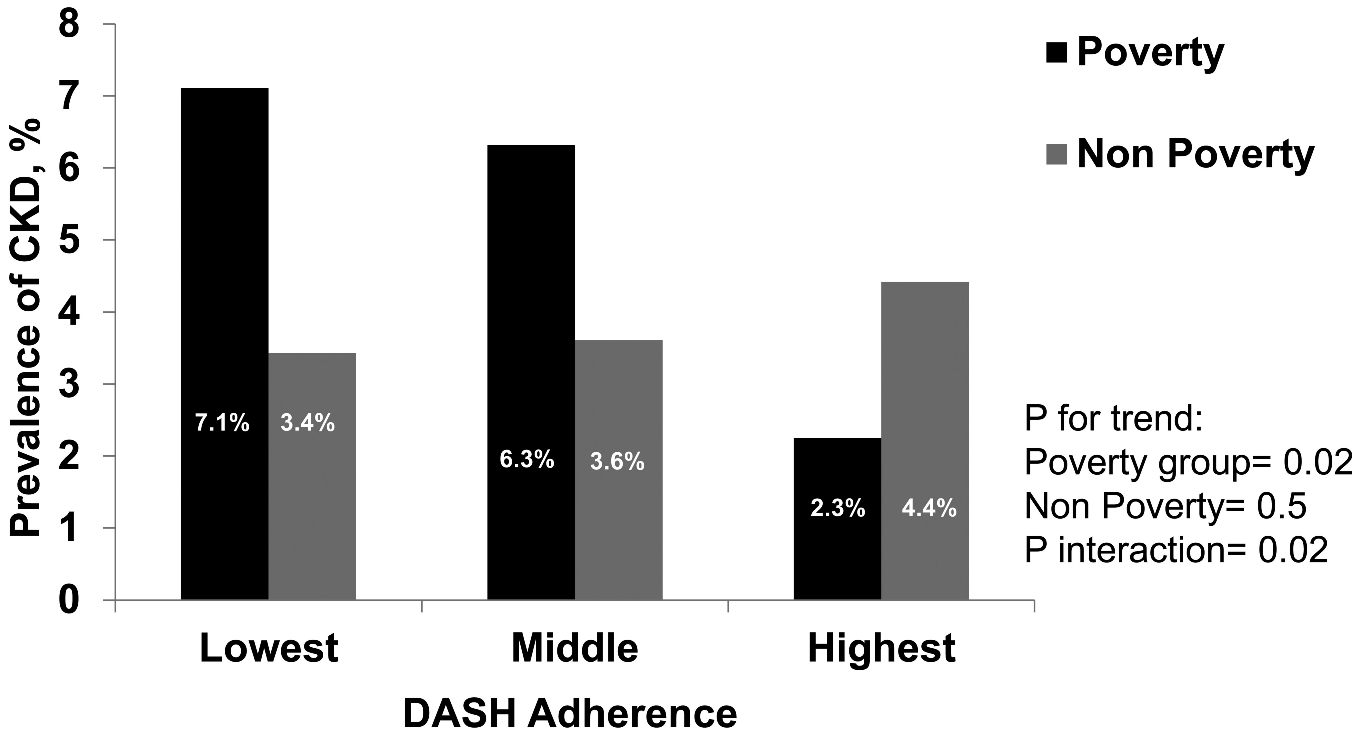


**Figure 1.**

Prevalence of CKD (eGFR<60 ml/min per 1.73m$^2$) by DASH Diet Adherence and Poverty Status

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**Table 1**

Dietary Approaches to Stop Hypertension (DASH) Diet Adherence Nutrient Intake Targets

| Nutrient | DASH Target | DASH Intermediate Target |
|---|---|---|
| Saturated fat, % energy | ≤6 | ≤11 |
| Total Fat, % energy | ≤27 | ≤32 |
| Protein, % energy | ≥18 | ≥16.5 |
| Cholesterol, mg/1000 kcal | ≤71.4 | ≤107.1 |
| Fiber, g/1000 kcal | ≥14.8 | ≥9.5 |
| Magnesium, mg/1000 kcal | ≥238 | ≥158 |
| Calcium, mg/1000 kcal | ≥590 | ≥402 |
| Potassium, gm/1000 kcal | ≥2238 | ≥1534 |
| Sodium, mg/1000 kcal | ≤1143 | ≤1286 |

*Note*: Individuals meeting the DASH target for a nutrient received a score of 1 while those who achieved the intermediate target for a nutrient received a score of 0.5 for that nutrient, for a total possible score of 9.[27,53]

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## Table 2

HANDLS Participant Characteristics by Poverty Status

| Characteristic | Poverty (N=869) | Non-Poverty (N=1189) | P value |
|---|---|---|---|
| Age, yrs; mean (SD) | 47.4 (9.1) | 48.2 (9.5) | 0.07 |
| Male Sex, % | 39.8 | 46.3 | 0.003 |
| Black Race, % | 68.5 | 48.6 | <0.001 |
| Education, yrs; mean (SD) | 11.6 (2.6) | 13.2 (3.2) | <0.001 |
| No Health Care Provider, % | 45.5 | 27.9 | <0.001 |
| Uninsured, % | 43.4 | 23.2 | <0.001 |
| Obesity, % | 40.7 | 43.2 | 0.3 |
| Diabetes, % | 17.2 | 15.8 | 0.4 |
| Fasting Plasma Glucose, mg/dl; mean (SD) | 105 (44) | 105 (44) | 0.9 |
| Hypertension, % | 49.3 | 42.4 | 0.002 |
| Systolic Blood Pressure, mmHg; mean (SD) | 121 (19) | 120 (19) | 0.07 |
| Tobacco Use, % | 58.2 | 39.7 | <0.001 |
| Average daily energy intake, kcal; mean (SE) | 2041 (36) | 1982 (26) | 0.2 |

Note: Poverty defined as a self-reported annual household income below 125% of the 2004 Department of Health and Human Services poverty guideline (family of 4 earning <$23,562).[21]

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**Table 3**

Dietary Approaches to Stop Hypertension (DASH) Nutrient Intakes by Poverty Status

| DASH nutrients | DASH Target | Poverty (n=869) Mean | Non-Poverty (n=1189) Mean | P value |
|---|---|---|---|---|
| Saturated fat, % energy | ≤6 | 11.5% | 11.3% | 0.3 |
| Total Fat, % energy | ≤27 | 35.2% | 34.6% | 0.1 |
| Protein, % energy | ≥18 | 15.9% | 15.8% | 0.5 |
| Cholesterol, mg/1000 kcal | ≤71.4 | 178.1 | 156.2 | <0.001 |
| Fiber, g/1000 kcal | ≥14.8 | 5.8 | 6.6 | <0.001 |
| Magnesium, mg/1000 kcal | ≥238 | 118.6 | 129.8 | <0.001 |
| Calcium, mg/1000 kcal | ≥590 | 360.9 | 391.2 | <0.001 |
| Potassium, gm/1000 kcal | ≥2238 | 1120.0 | 1200.3 | <0.001 |
| Sodium, mg/1000 kcal | ≤1143 | 1600.6 | 1598.5 | 0.9 |
| Total DASH score | 9.0 | 1.64 | 1.84 | <0.001 |
| DASH, % adherent (total score ≥4.5) | -- | 4.5 | 6.1 | 0.1 |

*Note*: Poverty defined as a self-reported annual household income below 125% of the 2004 Department of Health and Human Services poverty guideline (family of 4 earning <$23,562).[21]

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## Table 4

HANDLS Participant Characteristics by DASH Diet Adherence

| | **Lowest Adherence n=861 (DASH score 0-1)** | **Middle Adherence n=613 (DASH score 1.5-2)** | **Highest Adherence n=584 (DASH score 2.5-8)** | **P value** |
|---|---|---|---|---|
| Age, yrs; mean (SE) | 47.7 (0.31) | 47.6 (0.38) | 48.4 (0.40) | 0.2 |
| Male Sex, % | 46.5 | 46.0 | 36.8 | <0.001 |
| Black Race, % | 62.8 | 57.8 | 47.6 | <0.001 |
| Poverty Status, % | 45.8 | 41.3 | 38.0 | 0.01 |
| Education, years; mean (SE) | 12.2 (0.10) | 12.3 (0.12) | 13.1 (0.15) | <0.001 |
| No Provider, % | 38.0 | 36.1 | 30.7 | 0.02 |
| Uninsured, % | 33.8 | 31.5 | 28.9 | 0.1 |
| Obesity (BMI≥30), % | 42.0 | 44.2 | 40.1 | 0.3 |
| Diabetes, % | 15.9 | 16.5 | 17.0 | 0.9 |
| Fasting Plasma Glucose, mg/dl; mean (SE) | 105 (1.6) | 105 (1.7) | 105 (1.8) | 0.9 |
| Hypertension, % | 45.9 | 45.0 | 44.8 | 0.9 |
| Systolic Blood Pressure, mmHg; mean (SE) | 121 (0.65) | 121 (0.81) | 118 (0.74) | 0.01 |
| Tobacco Use, % | 51.7 | 48.9 | 39.6 | <0.001 |
| Average daily energy intake, kcal; mean (SE) | 2231 (36) | 2006 (39) | 1677 (32) | <0.001 |

Abbreviations: BMI, body mass index.

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## Table 5

Logistic Regression Models of Odds of CKD by DASH Diet Adherence Tertile, Stratified by Poverty Status

| | | Poverty (N=869) | | | Non-Poverty (N=1189) | | | P interaction |
|---|---|---|---|---|---|---|---|---|
| **Model** | **Variables Included** | **DASH Tertile** | **OR (95% CI)** | **p-value for trend** | **DASH Tertile** | **OR (95% CI)** | **p-value for trend** | **Between Poverty status and DASH tertile** |
| 1 | DASH score only | Lowest | 3.32 (1.88-5.88) | <0.001 | Lowest | 0.77 (0.43-1.37) | 0.377 | <0.001 |
| | | Middle | 2.93 (1.41-6.07) | | Middle | 0.81 (0.35-1.85) | | |
| | | Highest | reference | | Highest | reference | | |
| 2 | +age, sex, race | Lowest | 3.20 (1.72-5.96) | 0.001 | Lowest | 0.91 (0.45-1.85) | 0.801 | 0.001 |
| | | Middle | 2.85 (1.23-6.63) | | Middle | 0.98 (0.40-2.37) | | |
| | | Highest | reference | | Highest | reference | | |
| 3 | + years of education, regular health care provider | Lowest | 3.12 (1.68-5.80) | 0.001 | Lowest | 0.90 (0.45-1.80) | 0.778 | 0.001 |
| | | Middle | 2.73 (1.19-6.23) | | Middle | 0.91 (0.36-2.29) | | |
| | | Highest | reference | | Highest | reference | | |
| 4 | + diabetes, hypertension, smoking status, and average energy intake | Lowest | 3.15 (1.51-6.56) | 0.003 | Lowest | 0.73 (0.37-1.43) | 0.356 | 0.001 |
| | | Middle | 2.73 (1.22-6.13) | | Middle | 0.92 (0.39-2.18) | | |
| | | Highest | Reference | | Highest | reference | | |