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Evaluation of the Relationship Between Albuminuria and Food Insecurity in Women, Using the National Health and Nutrition Examination Survey

Heidi Cox

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By

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ABSTRACT

Context: Albuminuria, a clinical indicator of chronic kidney disease, has a high prevalence among the US population where approximately half of the people with this condition are women. In the US, most participants in food based government assistance programs are women who have food insecurity. Research indicates that obesity and diabetes, known risk factors for chronic kidney disease, are consequences of food insecurity.

Aim: The aim of this study is to examine racial-ethnic differences in the relationship between food insecurity and albuminuria in women who participated in the 2011-2012 NHANES.

Methods: Odds ratios from racial-ethnic specific multivariate logistic regression were used to determine the associations between food insecurity and albuminuria.

Results: Among all participants, black women had the highest rate of food insecurity at 36%. From multivariate analysis, it was determined that among non-Hispanic blacks that having albuminuria was associated (OR= 3.73 95% CI 1.47-9.44) with food insecurity. However, there was no statistically significant association between food insecurity and albuminuria (OR= 1.46 95% CI .501-4.261) for non-Hispanic whites.

Discussion: Significant racial-ethnic differences in the association between food insecurity and albuminuria were identified in Non-Hispanic black women. It is recommended that further studies be done to evaluate the biological basis of the relationship between albuminuria and food insecurity in black women. A public health intervention to improve food insecurity may help reduce the risk of albuminuria in black women.

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Chapter I: Introduction

Chronic Kidney Disease (CKD) is a nonreversible, non-communicable chronic disease that affects over 26 million people in the United States. CKD, also known as renal disease, is clinically indicated by albuminuria, a condition where a person's urine albumin to creatinine ratio is equal to30mg/g or greater (Suarez, Isakova, Anderson, Boulware, Wolf and Scialla, 2015). Adjusting for age, women account for more diagnoses of kidney dysfunction than men (Zhang and Rothenbacher, 2008). Type 2 Diabetes has a population prevalence of 9.3% and is the leading cause of kidney dysfunction in more than 44% of cases. More than 5% of individuals newly diagnosed with diabetes are concurrently diagnosed with some stage of CKD (Centers for Disease Control and Prevention National Diabetes Statistics Report, 2014). Most cases of Type 2 diabetes are the result of obesity and associated risk factors of poor nutrition and lack of physical exercise (Nam, Han, Park, Kim, Lee Cho and Kim, 2014).

Many people with nutrient poor diets have limited access and availability to affordable nutritious food, also known as food insecurity. To help cover the costs of food, people who have established and reported financial need can participate in government assistance programs through Women Infants and Children (WIC) or Supplemental Nutrition Assistance Program (SNAP). Approximately 61% of government assistance program recipients in the U.S are women who are the active heads of the household (Irving and Loveless, 2015). Women are found to consume less nutritious inexpensive foods in order to lessen the strain on household budgets (Adams, Grummer-Strawn and Chavez, 2003). As a result of nutrient poor diets, women with food insecurity have higher rates of obesity than men with food insecurity (Gooding, Walls and Richmond, 2012).

Obesity is a major risk factor associated with the growing epidemic of type 2 diabetes (Nam et.al, 2014). In the last three decades, the prevalence of type 2 diabetes has doubled in the United States (National Kidney foundation, 2002). As the number one cause of kidney disease, it is estimated that more than a third of people with diabetes will develop CKD over their lifetime (Nam et.al, 2014). Non-Hispanic black (NHB) people have the second highest rates of diabetes and renal dysfunction in the nation. In addition, NHB women have an incidence of diabetes and CKD that is twice that of Non-Hispanic white (NHW) women (National Institutes of Health of the U.S. Department of Health and Human Services, 2015).

With diet and eating behaviors playing a significant role in the development of obesity and diabetes, there is a question of what effect food insecurity has on women's risk for kidney dysfunction. This thesis is designed to provide better insight on the association between food insecurity and renal disease in women. The objective of this thesis is to assess the relationship between food insecurity and albuminuria in American women by addressing the following research questions:

1.) Are there racial-ethnic differences in food insecurity in women with albuminuria who participated in NHANES?

2.) Is there a relationship between food insecurity and albuminuria in women who participated in NHANES?

3.) Are there racial-ethnic differences in the association between food insecurity and albuminuria in women who participated in NHANES?

Chapter II: Review of Literature

Chronic kidney disease can asymptomatically progress in renal dysfunction (Garg, Kiberd, Clark, Haynes and Clase, 2002). End-stage renal disease sufferers have a dependence on dialysis treatments to replace vital kidney functions and are susceptible to premature death due to life threatening comorbidities high blood pressure and cardiovascular disease (Couser, Remuzzi, Mendis, Tonelli, 2011). As a societal burden, the costs in the US to manage CKD patients are approximately $1250 a month. If there are comorbidities, the costs can exceed $3000 a month. Approximately 24% of patients with CKD have readmission to hospitals within 30 days, which is a 7% higher readmission rate than those who do not have kidney disease (Saran, Li, Robinson et al., 2015).

To address growing public health concerns and costs to manage care, the National Kidney Foundation (2002) increased prevention efforts and emphasized methods of early detection of CKD. Among detection improvements is the inclusion of urine based albuminuria assessments to stratify risk. The primary risk factors for the development of albuminuria are obesity and diabetes (Nam, Han, Kim, Park, Yoon, Kim and Roh, 2015).

Long periods of eating diets rich in fat and sugar can lead to the development of obesity and consequential outcomes such as diabetes and albuminuria (Crews, Kuczmarski, Grubbs, Hedgeman, Shahinian, Evans and Powe, 2014). People from communities of lower socioeconomic status (SES) have been found to have a higher risk for these illnesses (Gooding et.al, 2012).

The availability of and access to quality foods is associated with socioeconomic status. The accessibility to nutrient poor or nutrient rich food influences eating behaviors and how people identify their level of food security. Food insecurity is defined as having uncertain or limited ability to obtain safe and nutritious goods without assistance (Gooding et.al, 2012). Adults who can independently afford the costs of nutritious food, and are not eligible to participate in food based government assistance programs, have food security. People from low-income areas may be unable to afford food with higher nutritional value for themselves and their dependents, and could be considered to be food insecure. People with food insecurity have been found to cyclically go through periods of hunger and or overconsumption of energy-dense/nutrient poor foods (Nguyen, Shuval, Bertmann and Yaroch, 2015). Over time, diets with less nutritious foods high in sodium, saturated fats and sugars result in negative health outcomes (Irving et.al, 2015).

Food insecurity has emerged as a significant contributing factor to the disproportional development of obesity and diabetes in individuals from lower SES backgrounds (Adams et.al, 2003). Once a financial need is established and reported, people with food insecurities may receive public assistance through Women Infants and Children (WIC) or Supplemental Nutrition Assistance Program (SNAP). The US offers these government assistance programs to supplement the costs of purchasing food (Irving et.al, 2015).

Multiple studies have found differences in obesity rates between adults who have been identified as being food insecure, receiving food based government assistance and those who do not. The 2009 United States Department of Agriculture (USDA) data showed that for the 14.7% of food insecure homes in America, approximately 37% are households with children headed by single women. Among those households, 25% are black (Gooding et.al, 2012). From a study using the USDA food sufficiency indicator, it was determined that women from households with food insecurity came from a lower socioeconomic status and were 30% more likely to be overweight or have obesity than women who did not report food insecurity (Adams et.al, 2003). Diminished access and availability to adequately nutritious food promotes people from lower SES to select and purchase less nutritious food based on inexpensive costs and convenience (Crews et.al, 2014). Research has shown that people who participate in the supplemental nutrition assistance program to aid their struggle for food costs exhibit a stronger negative health effect from food insecurity than individuals who do not participate in this program. As the leading demographic in food based assistance programs, women are at an increased risk for negative health outcomes (Gooding et.al, 2012).

The U.S Department of Health and Human Services Office of Minority Health (2015) reports that black people are 80 percent more likely to be diagnosed with diabetes than any other racial-ethnic group. In the US, blacks have a disproportionally higher prevalence of diabetes at 12.6% compared to their white counter parts at 7.1%. In addition, black people have the second highest rate of CKD in the nation (Gaskin, Thorpe, McGinty, Bower, Rohde, Young, Laveist and Dubay, 2014). In general, women have a higher prevalence of CKD than men, but non-Hispanic black women have the highest incidence for kidney disease among all racial-ethnic groups (Zhang et. al., 2008).

The literature published to date states that the topic of lower SES and the association to CKD should be studied because of the number of people affected (Vart, Gansevoort, Crews, Reijneveld and Bültmann, 2015). Through searches on women's health, albuminuria, SES and food insecurity, there were no studies found specifically on the affect of food insecurity on albuminuria status in women. It is unclear how food insecurity affects the health of American women with albuminuria.

Chapter III: Methods and Procedures

Source of Data

For this thesis, data from the 2011-2012 The U.S National Health and Nutrition Examination Survey (NHANES) is examined.

NHANES is a nationally representative sample of the United States population and objectively provides assessments of risk factors and statistics for various health outcomes based on clinical testing, demographic and socioeconomic statuses and dietary behaviors. The annual survey is a combination of in person/at home interviews and physical examinations performed in quality controlled mobile examination centers (MEC). These exams are conducted by trained medical personnel in 15 U.S locations. By design NHANES generates nationally representative health statistics that oversample non-Hispanic blacks and people at least 60 years old. The estimations for previously undiagnosed illnesses, risk factors and prevalence of major health outcomes, such as CKD, are produced from NHANES (Centers for Disease Control and Prevention, 2015).

Inclusion and Exclusion Criteria

To be eligible for inclusion in the thesis study, participants had to be women at least 18 years old and not pregnant (n=1415). Each eligible person had to have recorded values for age, gender, race/ethnicity, education, blood pressure, diabetes status, BMI, albumin and creatinine. People were excluded if they identified male as their gender, or were women confirmed to be pregnant. People who identified as Hispanic or Asian were excluded due to small sample sizes for both racial-ethnic groups.

Demographic and Examination Variables

Race was categorized non-Hispanic White (NHW) and non-Hispanic Black (NHB).

The following clinical and behavioral variables are controlled for in the study for being known risk factors for albuminuria:

- Body mass index (BMI), calculated as weight in kilogram divided by height in meters squared and ranged from underweight to obese.

- Diabetes was determined based on participant's yes or no response to the question "other than during pregnancy, have you ever been told by a doctor or other health professional that you have diabetes or sugar diabetes?"
- Blood pressure was determined based on participant's yes or no response to whether or not they have been told they had elevated blood pressure on two separate health visits.
- Smokers are defined if smoked >100 cigarettes during their lifetime.
- Heavy alcohol drinkers are defined as currently or formerly consuming 4/5 drinks each day.

To control for factors affecting socioeconomic status, the following income and education variables were selected for inclusion:

- Income-to-poverty ratio represents the ratio of family or non-relative incomes to their appropriate poverty threshold based on the size of the family. A ratio below 1.00 indicates that the respective family or unrelated individual's income are below the health and human services (HHS) definition of poverty. A ratio of 1.00 or greater indicates the household income is above the poverty level.
- Education is reported as the highest level of education reached or completed and is separated into the following three categories are: 1.) less than 9th grade education 2.) 9-12th grade or GED (with or without diploma) and 3.) college education (with or without degree).

Participants are designated as experiencing food insecurity based on a yes response to the following questions: a. In the last 12 months, 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? b. Have you/you or anyone in your household ever received SNAP (Supplemental Nutrition Assistance Program) or Food Stamp benefits? c. In the last 12 months have you/you or anyone in your household ever received SNAP (Supplemental Nutrition Assistance Program) or Food Stamp benefits? d. Do you/Does any member of your household currently receive SNAP or Food Stamp benefits? A response of yes to any question is indicative of having food insecurity.

Statistical Analysis

Analysis of the data was completed using the statistical program SAS 9.4. Racial differences for categorical variables were assessed using Pearson's chi-squared tests. Multiple logistic regression analyses were used to assess the relationship between food insecurity and albuminuria. Statistical adjustments were made for age, BMI, education, diabetes, hypertension, smoking status and alcohol consumption. Odds ratio (OR) from the multivariate logistic regression analysis was used to estimate the relationship between food insecurity (independent variable) and albuminuria (dependent variable). Statistical significance is determined at P-value < .05 and 95% confidence intervals for all analyses.

Chapter IV: Results

Table 1 presents the results of comparative analyses of study variables by race. Less than one-third of the total sample had a BMI that reflected a normal body weight. Most of the participants had some college level education, with NHW women having the highest rate of 65.9%. Compared to NHW, NHB women have the highest rate of obesity (54.7%) and the lowest monthly mean poverty ratio (2.1). There were no statistically significant racial differences in the rates of hypertension (P-value=0.3778) and high cholesterol (P-value= 0.357). The rate of diabetes was significantly higher among NHB compared to NHW (P-value <.0001). Results indicate that NHB women have the highest rate of diabetes (27.6%) which was statistically higher than the rate in NHW (14.6%).

Rates of albuminuria and food insecurity are presented for NHW and NHB women in Figure 1. Approximately one-fourth of all women participants in this study reported having food insecurity (26.5%). Results showed that among all women in the sample, NHB women had the highest rate of albuminuria (17.8%). The findings also showed that NHB women had the highest rate for food insecurity (36%) which was 16% higher than NHW women.

Table 2 presents the results of the univariate analysis of select independent variables and albuminuria stratified by race-ethnicity. In NHB women, there were statistically significant independent associations between age (OR=1.03 95%CI 1.01-1.06), food insecurity (OR=2.31 95%CI 1.41-3.80), diabetes (OR= 4.20 95%CI 2.49-7.10) and high cholesterol (OR= 1.92 95%CI 1.16-3.16) with albuminuria. Among NHW women, age (OR= 1.05 95%CI 1.03-1.07), food insecurity (OR= 1.73 95%CI 1.04-2.90), and diabetes (OR=3.45 95%CI 2.03-5.87) were independently associated with increased odds of albuminuria. In both NHB and NHW, increases in monthly income were associated with decreased odds of albuminuria.

Table 3 presents the results of race specific multivariate logistic regression analysis of the association between food insecurity and albuminuria adjusting for age, BMI, education, smoking and other independent variables. Among NHB women, food insecurity (OR= 3.73 95% CI 1.474-9.439) was associated with increased the odds of having albuminuria when controlling for all independent variables. Obesity was associated with increased odds of albuminuria in NHW with OR= 4.95 (95% CI 1.08-22.69). When stratifying by race, there was no statistically significant association between food insecurity and albuminuria in NHW women in the sample.

Chapter V: Discussion

The aim of this thesis study was to examine racial-ethnic differences in the relationship between food insecurity and albuminuria in women who participated in the 2011-2012 NHANES. From a nationally representative female study population, it was observed that when controlling for covariates there are some racial-ethnic differences in the association between food insecurity and albuminuria.

According to Crews et.al (2014), compared to people without food insecurity, people with food insecurity are more likely to have lower income, obesity due to nutrient poor diets and are at a higher risk for type 2 diabetes, the leading risk factor for CKD. Although more than one-fourth of this thesis study sample had food insecurity, univariate analysis results showed that NHB and NHW had mean monthly poverty ratios that were above an impoverished 1.00. Among NHW and NHB, the distributions of education levels obtained were not significantly different and had insignificant associations to albuminuria. In addition, there was no statistically significant association between obesity and albuminuria for neither NHB women (P-value=0.9097) nor NHW women (P-value=0.4483). However, the results from multivariate analysis showed that NHB, the group with higher rates of food insecurity, obesity and diabetes had higher odds of developing albuminuria (OR=3.73), which is consistent with the literature.

High blood pressure is both a consequence of and the second leading cause of CKD (National Kidney foundation, 2002). The prevalence rate of high blood pressure for this thesis study sample was approximately 85% for both NHB and NHW. In women, hypertension has been shown to independently negatively impact target organs like the kidneys (Palatini, Mos, Santonastaso, Saladini, Benetti, Mormino and Cozzio, 2011). However, results did not indicate any significant association to albuminuria for either racial-ethnic group. With such a high rate of high blood pressure in the sample, the lack of association between high blood pressure and albuminuria may be due to regular use of blood pressure medications by both the NHW and NHB women.

For both univariate and multivariable analyses, smoking and alcohol drinking behaviors were not significantly associated with albuminuria. The variables selected from NHANES to determine smoking and drinking statuses did not specify if or when the behaviors were concluded or last engaged in. By selecting variables with broad definition terms like "lifetime," reporting bias may have affected the behavioral variables association to albuminuria.

Strengths

One strength for the study was utilizing NHANES because of its robust nationally representative sampling measures.

Limitations

This thesis study had limitations to note. One, this study had a small sample size due to missing values for comorbidities and SES factors. Two, the samples mean ages were approximately 60 years old, but there was a lack of consideration for the effect of medications (prescription and non-prescription) the women in the sample may have been taking. Three, food insecurity can what foods people will purchase for their households. However, buying and dietary behavior variables were not measured in the analysis. Four, portions of the NHANES questionnaire relies on self-reported responses of SNAP participation which may have resulted in recall bias by participants. Five, food insecurity was reported at a collective/familial level limiting the evaluation of an individual's food insecurity and the relationship to albuminuria. Due to the cross-sectional nature of this study, we cannot determine a cause and effect relationship between food insecurity and albuminuria.

Conclusion

Despite the limitations, it can be concluded that the results from this study provide some support that there is a racial-ethnic difference in the association between food insecurity and albuminuria in non-Hispanic black women. The study findings could be used in the development of interventions that target the existing barriers to accessing affordable nutritious food in lower SES communities. It is recommended that further studies be done to further evaluate the biological basis of the relationship between albuminuria and food insecurity in black women. A public health intervention to improve food insecurity may help reduce the risk of CKD in black women. Through improved understandings of food insecurity and its relationship to health outcomes, the risks for chronic kidney disease can be further explained.

Table 1

Anthropometric, Demographic, Clinical and Behavioral Characteristics of Study Participants

Variables	**NHB** (n=439)	**NHW** (n=603)	P-value
Age (yrs): mean ± SD	61.0 ± 10.0	64.8 ± 11.9	<.0001
BMI			<.0001
Obese	240 (54.7%)	220 (36.4%)	
Overweight	104 (23.7%)	176 (29.1%)	
Normal Weight	65 (14.8%)	156 (25.8%)	
Underweight	30 (6.8%)	53 (8.8%)	
Education			<.0001
< 9^{th} Grade	22 (6.2%)	28 (5.3%)	
$=9^{th} \leq 12^{th}$ Grade	109 (30.8%)	152 (28.8%)	
≥ College	223 (63.0%)	348 (65.9%)	
Family Income			
Monthly poverty: mean ± SD	2.1 ± 1.5	2.5 ± 1.6	0.0028
Behavioral/Clinical			
Smoker	151 (34.4%)	286 (47.4%)	<.0001
Heavy Alcohol Drinker	24 (8.0%)	50 (11.0%)	0.1249
Diabetic	115 (27.6%)	86 (14.6%)	<.0001
Hypertensive	237 (84.6%)	273 (85.3%)	0.3778
High Cholesterol	194 (44.6%)	288 (47.9%)	0.357

NHB = Non-Hispanic Blacks, NHW = Non-Hispanic Whites SD = Standard Deviation, BMI=Body Mass Index (kg/m2). P-values for continuous and categorical variables were the result of ANOVA and chi-square tests respectively.

Table 2

Univariate Analysis of the Association between Independent Variables and Albuminuria by Race-Ethnicity

	OR (95% CI)			
Variables	**NHB** (n=439)	P-value	**NHW** (n=603)	P-value
Food Insecurity	2.31 (1.41-3.80)	0.0009	1.73 (1.04-2.90)	<.0001
Age	1.03 (1.01-1.06)	0.0065	1.05 (1.03-1.07)	<.0001
BMI				
Obese	1.06 (0.38-2.93)	0.9097	0.75 (0.35-1.59)	0.4483
Overweight	1.19 (0.41-3.50)	0.7510	0.60 (0.27-1.33)	0.2100
Normal Weight	1.02 (0.32-3.24)	0.9752	0.47 (0.20-1.07)	0.0733
Underweight	1.00 reference		1.00 reference	
Education				
< 9^{th} Grade	2.42 (0.92-6.37)	0.0723	2.29 (0.87-6.02)	0.0920
=$9^{th} \leq 12^{th}$ Grade	1.10 (0.60-2.02)	0.7670	1.73 (1.01-2.98)	0.0467
≥ College	1.00 reference		1.00 reference	
Monthly poverty	0.77 (0.62-0.95)	0.0141	0.77 (0.66-0.91)	0.0023
Behavioral/Clinical				
Smoker	1.16 (0.70-1.93)	0.5685	1.19 (0.76-1.88)	0.4420
Heavy Alcohol Drinker	1.74 (0.69-4.41)	0.2428	1.43 (0.66-3.11)	0.3650
Diabetic	4.20 (2.49-7.10)	<.0001	3.45 (2.03-5.87)	<.0001
Hypertensive	1.14 (0.52-2.53)	0.7438	1.00 (0.47-2.13)	0.9961
High Cholesterol	1.92 (1.16-3.16)	0.0110	1.33 (0.84-2.10)	0.2189

BMI=Body Mass Index (kg/m2), OR=Odds Ratio, 95% CI= 95% Confidence Interval

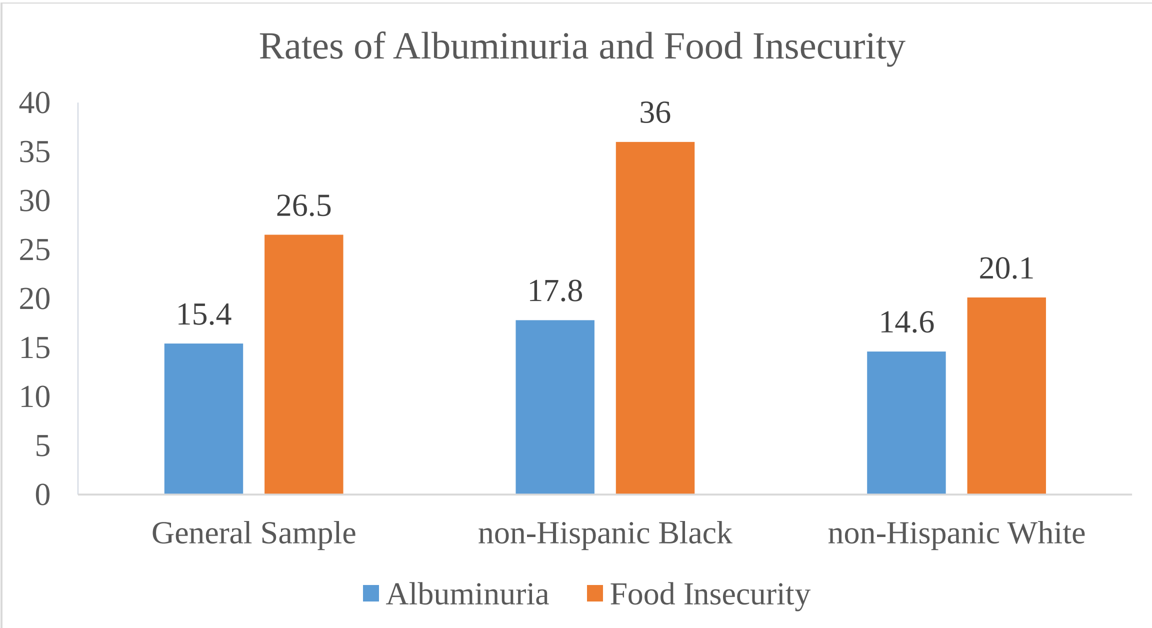
Table 3

Multivariate Analysis of the Association between Independent Variables and Albuminuria in Non-Hispanic Blacks compared with Non-Hispanic Whites.

Variables	**NHB**	**OR** (95% CI) P-value	**NHW**	P-value
Food Insecurity	3.73 (1.47-9.44)	0.0054	1.46 (0.50-4.26)	0.4881
Age	1.03 (0.97-1.09)	0.2860	0.95 (0.91-0.99)	0.0126
BMI				
Obese	4.00 (0.39-40.98)	0.2430	4.95 (1.08-22.69)	0.0398
Overweight	1.80 (0.16-20.25)	0.6355	8.25 (1.58-43.03)	0.0123
Normal Weight	1.36 (0.11-16.43)	0.8089	3.35 (0.67-16.83)	0.1414
Education				
<9th Grade	1.40 (0.22-9.08)	0.7223	2.76 (0.35-21.45)	0.3331
$=9^{th} \leq 12^{th}$ Grade	1.49 (0.53-4.22)	0.4486	1.02 (0.44-2.38)	0.9659
Smoker	2.05 (0.77-5.34)	0.1426	1.15 (0.52-2.54)	0.7222
Heavy Alcohol	5.75 (0.45-72.88)	0.1772	1.02 (0.26-3.96)	0.9789
Diabetic	0.23 (0.09-0.59)	0.0025	0.38 (0.14-0.98)	0.0455
Hypertensive	1.63 (0.47-5.70)	0.4426	1.06 (0.37-3.02)	0.9139
High Cholesterol	0.71 (0.28-1.75)	0.4527	1.21 (0.53-2.79)	0.6473

BMI=Body Mass Index (kg/m2), OR=Odds Ratio, 95% CI= 95% Confidence Interval

Figure 1



NHB = Non-Hispanic Blacks, NHW = Non-Hispanic Whites, Other = Other Races-Ethnicities.
Albuminuria is defined by a urine albumin to creatinine excretion level of 30mg/g and higher.
NHB p-value= 0.0008, NHW p-value= 0.0345

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