

Research Article

Racial Disparity in the Associations of Microalbuminuria and Macroalbuminuria with Odds of Hypertension: Results from the NHANES Study in the United States

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Received 23 October 2013; Accepted 14 November 2013

Academic Editors: Y. Iwashima and B. Waeber

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Background. Limited information is available on whether the associations of microalbuminuria and macroalbuminuria with the odds of hypertension differ among non-Hispanic Whites, non-Hispanic Blacks, and Hispanics. **Methods.** Cross-sectional data of 24,949 participants aged ≥ 18 years were collected from the National Health and Nutrition Examination Survey (NHANES) 1999–2008. Odds ratios of hypertension for microalbuminuria and macroalbuminuria were estimated by conducting weighted multiple logistic regression models. **Results.** After adjustment for extensive confounding factors, microalbuminuria is 1.45 (95% confidence interval (CI) [1.17, 1.80]), 2.07 (95% CI [1.52, 2.83]) and 2.81 (95% CI [2.06, 3.84]) times more likely to be associated with hypertension, and macroalbuminuria is 4.08 (95% CI [1.98, 8.38]), 8.62 (95% CI [3.84, 19.35]), and 4.43 (95% CI [2.13, 9.21]) times in non-Hispanic Whites, non-Hispanic Blacks, and Hispanics, respectively. The odds of hypertension for microalbuminuria (versus normalalbuminuria) were 52% higher in non-Hispanic Blacks and 98% higher in Hispanics than in non-Hispanic Whites; the odds of hypertension for macroalbuminuria (versus normalalbuminuria) did not differ among racial groups. **Conclusion.** Racial differences in the relation between microalbuminuria and hypertension are prevalent among non-Hispanic Whites, non-Hispanic Blacks, and Hispanics. More screening efforts should be encouraged in normotensive non-Hispanic Blacks and Hispanics with microalbuminuria.

1. Introduction

Hypertension has been a major public health concern that affects approximately 65 million people in the United States and is a major risk factor for cardiovascular and renal diseases [1–6]. Prevention of hypertension delays the progression of adverse cardiovascular and renal outcomes and reduces the morbidity and mortality related to these diseases. One of the goals in Healthy People 2020 is to reduce the proportion of US hypertensive adults to 26.9% [7].

Albuminuria is a clinical measure of extra albumin excretion occurring in the urine of the human body. The levels of albuminuria are usually determined by the ratio of spot urine albumin and creatinine. Microalbuminuria is defined as a urine albumin-to-creatinine ratio (UACR) ≥ 30 mg/g and < 300 mg/g and macroalbuminuria as a UACR ≥ 300 mg/g [8, 9]. Conventionally, hypertension is considered an important risk factor for renal dysfunction, including the development of albuminuria [10, 11], and Blacks and Hispanics are more susceptible to renal damage from hypertension, leading to

micro- and macroalbuminuria more often in hypertensive Blacks and Hispanics than in hypertensive Whites [12, 13]. Accumulating evidence suggests that the reverse is also probably true—increased rates of albumin excretion in non-hypertensive individuals predispose them to the development of hypertension, and micro- and macroalbuminuria in hypertensive subjects predict lesser blood pressure reduction and delay the time to attainment of blood pressure goal [14–16]. However, limited information is available on how microalbuminuria and macroalbuminuria are associated with the odds of hypertension and whether these associations are stronger in non-Hispanic Blacks and Hispanics than in non-Hispanic Whites in the general population.

In this study, we used the National Health and Nutrition Examination Survey (NHANES) to examine the differences in associations of microalbuminuria and macroalbuminuria with hypertension among non-Hispanic Whites, non-Hispanic Blacks, and Hispanics. We hypothesized that microalbuminuria and macroalbuminuria were significantly associated with the odds of hypertension and the associations are stronger in non-Hispanic Blacks and Hispanics than in non-Hispanic Whites, after adjustment for established confounding factors. The prevalence of hypertension has been shown to be higher in Blacks and Hispanics than in Whites [17–19]. This difference may be attributed to racial disparities in clinical risk factors for hypertension. Understanding the variation in the associations of microalbuminuria and macroalbuminuria with hypertension in different racial groups would be critical in developing measures to prevent hypertension.

2. Methods

2.1. Study Sample. Our analysis was based on the data from the continuous NHANES program conducted by the National Center for Health Statistics in the Centers for Disease Control and Prevention [20]. Beginning in 1999, the continuous NHANES included a series of two-year cross-sectional surveys designed to monitor the health status and nutrition among adults and children in the United States (US). In each two-year cycle of the survey, a nationally representative sample of the US civilian noninstitutionalized population was selected using a complex stratified multistage probability-clustered sampling design. Approximately 10,000 persons selected from 30 counties across the country were examined in each cycle of the survey. The survey consisted of interviews and examination. Interviews were performed in the participants' home to obtain information regarding sociodemographic characteristics and history of diseases. Examination was conducted in the Mobile Examination Center to obtain measurements about examination and clinical/laboratory factors. All participants provided informed consent and the data were approved by the Centers for Disease Control and Prevention Institutional Review Board to ensure confidentiality.

We included five cycles of NHANES survey data from 1999 to 2008 to have adequate sample sizes and power for subgroup analyses. For our analysis, participants aged 18 or

younger were excluded. We also excluded those persons who only participated in the interview or examination, but not both, who were multi-racial or who were pregnant females. Finally, 24,949 participants were available in the continuous NHANES for further study (see Figure 1 for details on the flow of participants through the study).

2.2. Outcome Measures. The certified physician examiners operated blood pressure measurements by using mercury sphygmomanometer and a standardized procedure in the medical examination center during the examination. Three or four systolic blood pressure and diastolic blood pressure readings on each participant were recorded for accuracy consideration. The average systolic blood pressure and diastolic blood pressure were calculated based on the individual readings according to the NHANES specifications. A participant was considered to have hypertension if his/her average systolic blood pressure was ≥ 140 mm Hg or average diastolic blood pressure was ≥ 90 mm Hg or if s/he was taking hypertensive medications.

2.3. Primary Factor. Albuminuria was determined by the ratio of spot urine albumin and creatinine measured from participants. Urinary albumin was measured using a standard solid-phase fluorescent immunoassay which is a noncompetitive, double-antibody method for the determination of human albumin in urine. A Jaffé rate reaction, in which creatinine reacts with picrate in an alkaline solution to form a red creatinine-picrate complex, was used to analyze creatinine, and reaction was measured with a CX3 analyzer. In our study, albuminuria was classified as microalbuminuria and macroalbuminuria according to the levels of UACR. A participant was determined to have microalbuminuria if his or her UACR level was ≥ 30 mg/g and < 300 mg/g, and macroalbuminuria if his or her UACR level was ≥ 300 mg/g.

2.4. Other Factors of Interest. Sociodemographic information on age, gender, race, education, and smoking use was assessed through questionnaire files of NHANES. The level of education was classified as receiving education of high school or less, and college or above, based on the number of years in school. Poverty was defined as a poverty index ratio ≤ 1.0 . The poverty index ratio was the ratio of the family's total income to the family's appropriate poverty threshold. Tobacco use was divided into three categories: never using, former using, and current using. Body mass index was calculated as weight in kilograms divided by the square of height in meters. Weight and height were measured in the medical examination center in each two-year cycle of the survey using standardized protocols and calibrated equipment. Participants were determined to have diabetes if they were previously diagnosed by physicians or if they were on antidiabetic medications at the time of examination. A participant had elevated serum cholesterol if the blood sample level was ≥ 200 mg/dL. Standardized estimated glomerular filtration rate (eGFR) was derived from standard serum creatinine, age, race, and gender according to recommendations from the National Kidney Disease Education Program. The estimating equation

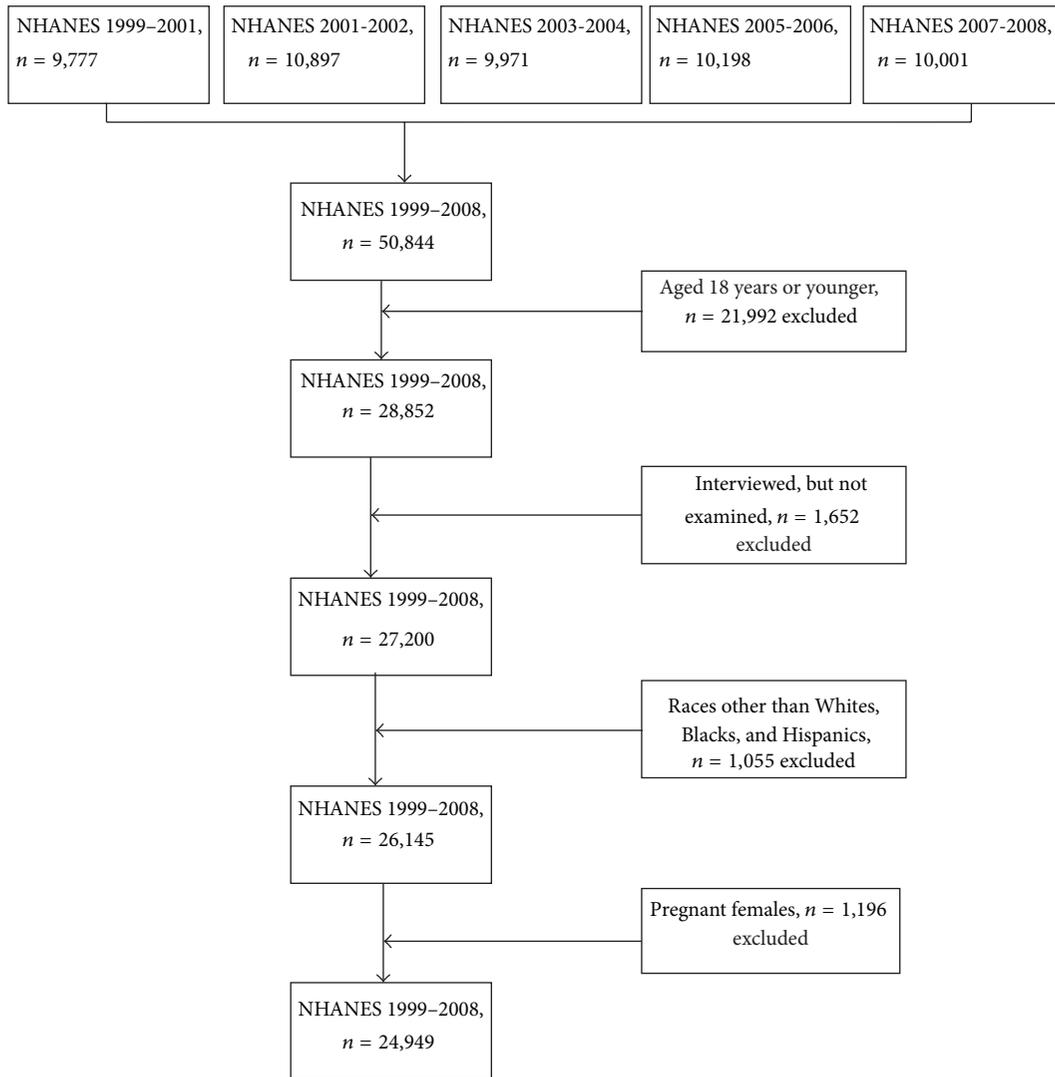


FIGURE 1: Block diagram for the flow of participants through the study.

used was $[\text{standardized eGFR}] = 175 * [\text{standard serum creatinine}^{-1.154}] * [\text{age}^{-0.203}] * [0.742 \text{ for female}] * [1.212 \text{ for African Americans}]$ [21]. The serum creatinine specimens were analyzed by using a Roche coupled enzymatic assay performed on a Roche P Module instrument.

2.5. Statistical Analysis. The study sample was a stratified multistage sample obtained by combining five two-year cycles of continuous NHANES, including data from demographic, examination, lab, and questionnaire. To reflect unequal probabilities of selection, nonresponse adjustments and poststratification adjustments, examination sampling weights were incorporated into the data analysis to get proper estimates and sampling errors of estimates. Sampling weights were also used to adjust for the impact of oversampling non-Hispanic Blacks, Hispanics, and individuals aged 60 years or older in the NHANES survey.

Statistical analyses were performed using SAS statistical software (SAS, version 9.2, SAS Institute, Cary, NC). We evaluated descriptive statistics for subject characteristics, including demographics, comorbidities, and outcome measures, across the levels of albuminuria by using PROC SURVEYMEANS for continuous variables and PROC SURVEYREG for categorical values. 95% confidence intervals (CIs) were calculated to examine the difference of characteristics over the levels of albuminuria. Age-adjusted prevalence of microalbuminuria and macroalbuminuria was calculated across racial groups, as well as across diabetes status stratified by race and hypertension status, by running survey regression models. Weighted multiple logistic regression models were conducted to examine odds ratios of hypertension associated with microalbuminuria and macroalbuminuria in different racial/ethnic populations, adjusted for the influence of established confounding factors. Relative odds ratios were calculated to pair-wisely compare the odds of hypertension

TABLE 1: Characteristics of participants by levels of albuminuria in NHANES 1999–2008, United States.

Characteristics	Means or percentages (95% confidence interval)		
	Normalalbuminuria	Microalbuminuria	Macroalbuminuria
Age, years	44.7 (44.2, 45.2)	54.5 (53.4, 55.5)	58.7 (56.7, 60.7) [‡]
Gender			
Female %	50.8 (50.2, 51.3)	57.2 (54.5, 59.9)	51.8 (44.6, 59.1) [†]
Education			
High school or below %	46.1 (44.3, 47.9)	53.0 (49.3, 56.6)	65.6 (57.3, 74.0) [‡]
Race			
Non-Hispanic Whites %	75.5 (73.0, 78.0)	66.6 (62.7, 70.4)	50.5 (42.3, 58.7) [‡]
Non-Hispanic Blacks %	11.2 (9.5, 12.8)	15.1 (12.5, 17.7)	26.3 (20.3, 32.4) [‡]
Hispanics %	13.3 (11.2, 15.4)	18.3 (14.9, 21.7)	23.1 (15.7, 30.5) [‡]
Poverty (yes) %	12.6 (11.6, 13.6)	19.4 (16.8, 22.0)	28.9 (22.1, 35.7) [‡]
Body mass index (kg/m ²)	28.1 (27.9, 28.3)	29.4 (28.8, 30.0)	30.5 (29.3, 31.8) [‡]
Smoking			
Former smoking %	24.6 (23.7, 25.5)	23.3 (21.4, 25.3)	20.4 (15.7, 25.1)
Current smoking %	31.4 (30.1, 32.7)	34.5 (31.2, 37.9)	37.7 (30.3, 45.2) [*]
Diabetes (yes) %	5.6 (5.2, 6.0)	18.2 (15.8, 20.5)	30.2 (25.2, 35.3) [‡]
Serum cholesterol ≥ 200 (mg/dL) %	46.0 (44.9, 47.0)	45.7 (42.3, 49.0)	46.8 (38.7, 54.8)
eGFR < 60 (mL/min/1.73 m ²)	6.9 (6.4, 7.4)	10.8 (9.4, 12.2)	31.1 (25.7, 36.5) [‡]
Hypertension (yes) %	27.6 (26.8, 28.5)	41.5 (39.2, 43.9)	65.1 (57.7, 72.6) [‡]

Note: data were age-adjusted (except for age-specific estimates) by direct standardization to the 2000 projected US population.

eGFR: estimated glomerular filtration rate.

[‡] $P < 0.0001$, [†] $P < 0.01$, ^{*} $P < 0.05$.

associated with microalbuminuria and macroalbuminuria among non-Hispanic Whites, non-Hispanic Blacks, and Hispanics.

3. Results

Average age of the participants in the study sample was 45.8 (± 0.25) years. 51.0% ($\pm 0.30\%$) were women, 13.7% ($\pm 1.09\%$) were Hispanics, 74.6% ($\pm 1.29\%$) were non-Hispanic Whites, and 11.8% ($\pm 0.86\%$) were non-Hispanic Blacks. Among the participants, 1.4% ($\pm 0.08\%$) had macroalbuminuria, 8.2% ($\pm 0.22\%$) had microalbuminuria, and 7.3% ($\pm 0.24\%$) had diagnosed diabetes. Overall prevalence of hypertension in the general US population between 1999 and 2008 was 29.5% ($\pm 0.42\%$).

Table 1 presents the means or percentages and the 95% CIs of participant characteristics by levels of albuminuria in NHANES 1999–2008. The subjects with microalbuminuria were older than those with normalalbuminuria, but younger than those with macroalbuminuria. After age adjustment, there were significant differences in the characteristics of participants with normalalbuminuria, microalbuminuria, and macroalbuminuria. The proportion of females was higher in microalbuminuria than in normalalbuminuria. Participants with microalbuminuria and macroalbuminuria were poorer, received lower education, and had a higher average of body mass index compared with participants with normalalbuminuria. The prevalence of diabetes, eGFR, and hypertension was

the highest in participants with macroalbuminuria and the lowest in those with normalalbuminuria.

The odds ratios of hypertension associated with microalbuminuria and macroalbuminuria among non-Hispanic Whites, non-Hispanic Blacks, and Hispanics in NHANES 1999–2008 are listed in Table 2. Overall analysis showed that, after adjustment for age, gender, education, smoking, poverty, body mass index, diabetes, serum cholesterol, and eGFR, both microalbuminuria and macroalbuminuria increased the odds of hypertension in the general population of participants in the US (odds ratio (OR): 1.69, 95% confidence interval (CI): 1.43–1.98 for microalbuminuria; OR: 5.00, 95% CI: 3.09–8.10 for macroalbuminuria). Separate analyses revealed that the odds of hypertension increased in participants with microalbuminuria or macroalbuminuria among all three racial groups. After adjustment for the same extensive confounding factors, the association of microalbuminuria with the odds of hypertension was highly significant for non-Hispanic Blacks and Hispanics (OR: 2.07, 95% CI: 1.52–2.83 for non-Hispanic Blacks, $P < 0.0001$; OR: 2.81, 95% CI: 2.06–3.84 for Hispanics, $P < 0.0001$) and significant for non-Hispanic Whites (OR: 1.45, 95% CI: 1.17–1.80 for non-Hispanic Whites, $P < 0.01$), and the association of macroalbuminuria was highly significant for all three racial groups (OR: 4.08, 95% CI: 1.98–8.38 for non-Hispanic Whites; OR: 8.62, 95% CI: 3.84–19.35 for non-Hispanic Blacks; OR: 4.43, 95% CI: 2.13–9.21 for Hispanics; all P values < 0.0001). For other models adjusted for fewer potential confounding factors (models I–IV in Table 2),

TABLE 2: Odds ratios of hypertension associated with microalbuminuria and macroalbuminuria by race among participants in NHANES 1999–2008, United States.

Characteristics	Odds ratios (95% confidence interval)			
	Non-Hispanic Whites	Non-Hispanic Blacks	Hispanics	Overall
Model I				
Microalbuminuria	2.89 (2.54, 3.29) [‡]	3.88 (3.16, 4.76) [‡]	4.03 (3.14, 5.17) [‡]	3.08 (2.79, 3.40) [‡]
Macroalbuminuria	11.21 (7.09, 17.72) [‡]	14.74 (8.47, 25.66) [‡]	8.85 (5.78, 13.56) [‡]	10.52 (7.98, 13.87) [‡]
Model II				
Microalbuminuria	1.72 (1.45, 2.05) [‡]	2.55 (1.99, 3.28) [‡]	3.12 (2.28, 4.26) [‡]	2.03 (1.79, 2.31) [‡]
Macroalbuminuria	6.28 (3.73, 10.56) [‡]	10.34 (5.61, 19.08) [‡]	6.00 (3.05, 11.80) [‡]	7.08 (5.01, 10.00) [‡]
Model III				
Microalbuminuria	1.70 (1.42, 2.03) [‡]	2.52 (1.96, 3.24) [‡]	3.16 (2.25, 4.46) [‡]	2.00 (1.75, 2.29) [‡]
Macroalbuminuria	5.91 (3.46, 10.12) [‡]	10.15 (5.47, 18.83) [‡]	5.65 (2.83, 11.28) [‡]	6.72 (4.72, 9.55) [‡]
Model IV				
Microalbuminuria	1.54 (1.27, 1.86) [‡]	2.32 (1.75, 3.05) [‡]	3.01 (2.15, 4.21) [‡]	1.81 (1.57, 2.08) [‡]
Macroalbuminuria	4.92 (2.55, 9.50) [‡]	13.05 (5.57, 30.54) [‡]	4.92 (2.57, 9.44) [‡]	5.99 (3.89, 9.20) [‡]
Model V				
Microalbuminuria	1.45 (1.17, 1.80) [†]	2.07 (1.52, 2.83) [‡]	2.81 (2.06, 3.84) [‡]	1.69 (1.43, 1.98) [‡]
Macroalbuminuria	4.08 (1.98, 8.38) [‡]	8.62 (3.84, 19.35) [‡]	4.43 (2.13, 9.21) [‡]	5.00 (3.09, 8.10) [‡]

Note: odds ratios of hypertension were obtained by conducting weighted multiple logistic regression models. Model I: a crude model only adjusted for survey cycle; Model II: adjusted for survey cycle, age, gender, and education; Model III: Model II plus family poverty index ratio; Model IV: Model III plus body mass index and smoking status; Model V: Model IV plus diabetes mellitus, serum cholesterol, and standardized estimated glomerular filtration rate.

[‡] $P < 0.0001$, [†] $P < 0.01$.

the associations among microalbuminuria, macroalbuminuria, and the odds of hypertension remained highly significant in all racial groups (all P values < 0.0001).

Racial differences in microalbuminuria and macroalbuminuria after adjustment for age are shown in Figure 2. The prevalence of microalbuminuria was significantly higher in non-Hispanic Blacks and Hispanics than in non-Hispanic Whites. Non-Hispanic Blacks had the highest prevalence and non-Hispanic Whites had the lowest prevalence of macroalbuminuria in the general population.

Table 3 shows pair-wise comparisons of odds ratios of hypertension associated with microalbuminuria and macroalbuminuria among non-Hispanic Whites, non-Hispanic Blacks, and Hispanics in NHANES 1999–2008. The odds of hypertension for microalbuminuria are significantly different across racial groups. The increased odds of hypertension by microalbuminuria are 52% higher in non-Hispanic Blacks (relative OR: 1.52, 95% CI: 1.08–2.13, $P < 0.05$) and 98% higher in Hispanics (relative OR: 1.98, 95% CI: 1.30–3.01, $P < 0.01$), respectively, than in non-Hispanic Whites. The racial difference in the association between macroalbuminuria and hypertension was not significant.

4. Discussion

The associations of microalbuminuria and macroalbuminuria with the odds of hypertension were shown to be significant in all three racial groups. Compared with normalalbuminuria, microalbuminuria increased the odds of hypertension by 1.45, 2.07, and 2.81 times in non-Hispanic Whites, non-Hispanic Blacks, and Hispanics, respectively; and macroalbuminuria increased by 4.08, 8.62 and 4.43 times. The results are

similar to previous findings that link microalbuminuria and macroalbuminuria to uncontrolled blood pressure among hypertensive patients [16, 22]. Flack et al. examined the associations of microalbuminuria and macroalbuminuria at baseline with uncontrolled blood pressure and the initial attainment to the goal of blood pressure control in Black hypertensive patients [16]. Liu et al. linked the association of albuminuria with uncontrolled blood pressure among non-Hispanic Whites, non-Hispanic Blacks, and Hispanics with diagnosed hypertension [22]. However, in contrast to our study, the two previous studies only examined hypertensive patients with high cardiovascular risk and did not investigate the associations of microalbuminuria and macroalbuminuria with the odds of hypertension in the general population.

The present research extends previously published studies which did not examine the associations between albuminuria and hypertension separately with racial/ethnic representation of non-Hispanic Whites, Hispanics, and non-Hispanic Blacks [15, 16]. Our results imply that microalbuminuria and macroalbuminuria are important risk factors for hypertension, irrespective of non-Hispanic Whites, non-Hispanic Blacks, or Hispanics. Microalbuminuria has been linked to glomerular hyperfiltration, increased glomerular permeability, and increased intraglomerular pressure [23]. An association between microalbuminuria and hypertension is not surprising since glomerular injury, irrespective of etiology, typically leads to a rise in blood pressure [24]. Microalbuminuria is also an important marker for cardiovascular disease and consistently predicts cardiovascular events and mortality in the general population [25]. Regular screening for microalbuminuria ($30 \text{ mg/g} \leq \text{UACR} < 300 \text{ mg/g}$) is crucial to prevention of hypertension and cardiovascular

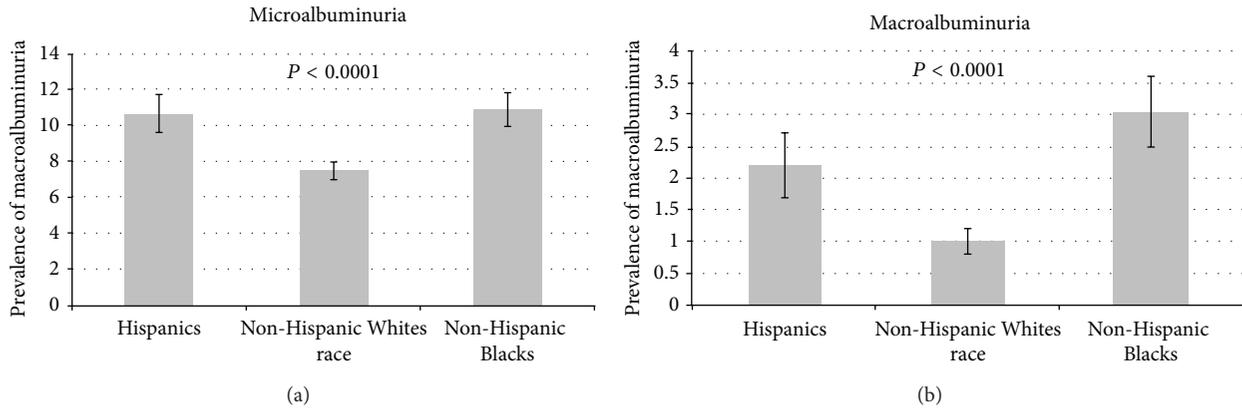


FIGURE 2: Prevalence and 95% confidence intervals of microalbuminuria and macroalbuminuria by race in NHANES 1999–2008, United States.

TABLE 3: Relative odds ratios of hypertension between racial groups for participants with microalbuminuria and macroalbuminuria in NHANES 1999–2008, United States.

Comparison between groups	Relative odds ratios (95% confidence interval)	
	Microalbuminuria	Macroalbuminuria
Non-Hispanic Blacks versus non-Hispanic Whites	1.52 (1.08, 2.13)*	2.50 (0.75, 8.29)
Hispanics versus non-Hispanic Whites	1.98 (1.30, 3.01) [†]	1.09 (0.42, 2.86)
Non-Hispanic Blacks versus Hispanics	0.77 (0.50, 1.17)	2.28 (0.76, 6.82)

Note: relative odds ratios of hypertension were obtained from the odds ratio of hypertension associated with microalbuminuria or macroalbuminuria (versus normalalbuminuria) in one racial group divided by the corresponding odds ratio of hypertension in another racial group by conducting weighted multiple logistic regression models including race, microalbuminuria, macroalbuminuria, and interactions of race microalbuminuria and macroalbuminuria, adjusted for survey cycle, age, gender, education, family poverty index ratio, body mass index, smoking status, diabetes mellitus, serum cholesterol, and standardized estimated glomerular filtration rate.

[†] $P < 0.01$, * $P < 0.05$.

events for all racial/ethnic groups in the general population. Macroalbuminuria is a more severe form of albuminuria and may involve severe renal damage as the underlying cause [26]. The kidney has been shown to play a critical role in the pathogenesis of hypertension in the case of severe renal impairment [26–28], providing a possible pathway whereby macroalbuminuria may be highly associated with the odds of hypertension.

Microalbuminuria and macroalbuminuria were more prevalent in non-Hispanic Blacks and Hispanics than in non-Hispanic Whites in the general US population in the present study (Figure 1). The results confirm the findings from previous studies [22, 29, 30]. Reasons for the higher prevalence of microalbuminuria and macroalbuminuria in Hispanics and Blacks are likely multifactorial and may include genetic factors, environmental exposures, or residual confounding. The prevalence of diabetes, an important risk factor for albuminuria, is higher and has not been improved in the population of Hispanics and Blacks [22]. Generalized obesity and high serum cholesterol are also strong and independent risk factors for albuminuria in these populations [10, 30]. Hispanics are at greater predisposition to develop high cholesterol levels than non-Hispanic Whites for genetic reasons and lifestyle habits [31]. Blacks are more likely to have obesity due to the limited consumption of fewer fruits and vegetables compared with other race/ethnicity groups [32].

Prevention, early detection, and aggressive treatment of diabetes, obesity, and high lipoprotein might help reduce racial differences in albuminuria, including microalbuminuria and macroalbuminuria.

Although microalbuminuria increased the odds of hypertension in all three racial groups (Table 2), the odds of hypertension elevated by microalbuminuria (versus normalalbuminuria) were higher in non-Hispanic Blacks (relative OR: 1.52) and Hispanics (relative OR: 1.98) than in non-Hispanic Whites (Table 3). Our results revealed that after adjustment for potential confounding factors, microalbuminuria was differently associated with hypertension in the population of non-Hispanic Whites, non-Hispanic Blacks, and Hispanics. Nevertheless, there was no racial difference in the association between macroalbuminuria and hypertension, implying that the relation between macroalbuminuria and the odds of hypertension is independent of race/ethnicity. The mechanism for stronger associations of microalbuminuria with the odds of hypertension in non-Hispanic Blacks and Hispanics than in non-Hispanic Whites is still unclear. Endothelial dysfunction has been shown to be correlated with microalbuminuria [33]. The association between microalbuminuria and generalized endothelial dysfunction could explain our findings. Generalized endothelial dysfunction has been suggested to play a role in the cause of hypertension [34, 35]. Racial differences exist in endothelial metabolism which

highlights racial differences in the predisposition to endothelial dysfunction [36], indicating that Blacks and Hispanics may be more susceptible to endothelial dysfunction and thus hypertension with the change of UACR to microalbuminuria. This may provide a pathway whereby the stronger associations of microalbuminuria have been shown in non-Hispanic Blacks and Hispanics. As to macroalbuminuria, since it is a high phase of albuminuria which is associated with severe and inconvertible endothelial dysfunction in all racial populations of non-Hispanic Whites, non-Hispanic Blacks, and Hispanics, the associations of macroalbuminuria with the odds of hypertension are all significant, but does not make a difference among three racial groups.

The strength of the study includes the rigor of sampling designs and the quality of the measurements used in NHANES. The results are representative of the US non-institutionalized civilian population. However, there were several limitations in this study. Continuous NHANES was a cross-sectional survey without follow-up information for participants. While the findings in the study could reflect the associations of microalbuminuria and macroalbuminuria with the odds of hypertension, they could not be used for causal effects of microalbuminuria and macroalbuminuria on development of hypertension in different racial populations with the follow-up in the cohort design. There may be unrecognized measurements confounding the associations of microalbuminuria and macroalbuminuria with the odds of hypertension even though we have adjusted for several confounding factors. Our study examined differences in microalbuminuria and macroalbuminuria, and their associations with the odds of hypertension over non-Hispanic Whites, non-Hispanic Blacks and Hispanics in the USA. The results cannot be extended to other racial groups (e.g., Asians and American Indians/Alaska Natives).

Stronger associations of microalbuminuria with the odds of hypertension in non-Hispanic Blacks and Hispanics indicate that clinicians should consider more frequent checking for albumin and creatinine levels in non-Hispanic Blacks and Hispanics without hypertension than in normotensive non-Hispanic Whites. This may help clinicians narrow the target population of subjects who should be aggressively approached with lifestyle change and behavioral change issues. Issues surrounding this from a clinical standpoint include the cost of running the test, supplies needed, and facility availability. However, compared with the cost and burden of hypertension and cardiovascular complications, these issues are trivial and necessary to be solved. More frequent screening for albuminuria in normotensive non-Hispanic Blacks and Hispanics may allow prevention or early detection of hypertension which would lead to early intervention of hypertension and reduce the risk and cost of cardiovascular disease and diabetic nephropathy in these racial groups. The objective of Healthy People 2020 for hypertension is to reduce the proportion of adults with hypertension to be 26.9% in the general US population [7]. The early screening tool for albuminuria in non-Hispanic Blacks and Hispanics would be critical and beneficial to reduce racial differences in the prevalence of hypertension and attain the goal of Healthy People 2020 for hypertension.

Future studies are needed to quantify how often to implement the earlier screening and the effectiveness of earlier screening for albuminuria in normotensive non-Hispanic Blacks and Hispanics for the prevention of hypertension and adverse cardiovascular outcomes.

Conflict of Interests

The authors declare that they have no conflict of interests.

Acknowledgments

Research for this study was supported by an HRSA grant. The authors thank the National Center of Health Statistics for the availability of NHANES survey data.

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