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The Association of Poverty With the Prevalence of Albuminuria: Data From the Third National Health and Nutrition Examination Survey (NHANES III)

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Abstract

Background—Albuminuria is a major risk factor for the development and progression of chronic kidney disease (CKD) and cardiovascular disease. Socioeconomic factors also have been reported to modify CKD and cardiovascular risk factors and clinical outcomes. The extent to which poverty influences the prevalence of albuminuria, particularly among racial/ethnic minority populations, is not well established. The influence of poverty on the prevalence of albuminuria and the implication of this relationship for the racial and/or ethnic differences in the prevalence of albuminuria were examined.

Methods—We examined data from 6,850 male and 7,634 female adults from a national probability survey conducted between 1988 and 1994.

Results—In univariate analysis, poverty, defined as less than 200% federal poverty level (FPL), was associated with the presence of both microalbuminuria (odds ratio [OR], 1.35; 95% confidence interval, 1.22 to 1.49) and macroalbuminuria (OR, 1.78; 95% confidence interval, 1.40 to 2.26). The association of less than 200% FPL with microalbuminuria persisted in a multivariate model controlling for age, sex, race, education, obesity, hypertension, diabetes, reduced glomerular filtration rate, and medication use (OR, 1.18; 95% confidence interval, 1.05 to 1.33). FPL less than 200% was not associated with macroalbuminuria in the multivariate model. When multivariate analysis is stratified by FPL (<200% and ≥200%), differences in ORs for microalbuminuria and macroalbuminuria among racial/ethnic minority participants compared with whites were more apparent among the less affluent participants in the FPL-less-than-200% stratum.

Conclusion—FPL less than 200% is associated with microalbuminuria, and differences in FPL levels may account for some of the observed differences in prevalence of albuminuria between racial/ethnic minority participants and their white counterparts.

INDEX WORDS

Chronic kidney disease (CKD); poverty; albuminuria; minority

Chronic kidney disease (CKD) is a significant cause of morbidity and mortality in adult Americans. Excessive urinary albumin excretion is an established risk factor for CKD

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progression and an independent risk factor for cardiovascular disease (CVD).[1–5] In addition to the underlying primary pathological state, several factors, such as lifestyle, socioeconomic status (SES), and occupational exposures, were suggested to modify the progression and outcome of kidney diseases and may be responsible, in part, for the disproportionately high rates of end-stage renal disease in such subgroups as racial/ethnic minorities.[6–10] African Americans were reported to have greater rates of proteinuria.[11] It also is known that racial and ethnic minority status in the United States often is associated with low SES, and these factors may impact on clinical outcomes in a wide variety of diseases, including CVD and CKD.[12–14] The association between racial and ethnic minority status and low SES may mask important differences in clinical risk profiles. This differentiation is crucial for the planning and implementation of effective prevention and control strategies. The purpose of this study is to evaluate the effect of the federal poverty level (FPL) as an index of SES on the prevalence of albuminuria, an important marker of CKD and CVD risk.

METHODS

This study used data from the Third National Health and Nutrition Examination Survey (NHANES III). NHANES III is a national probability survey conducted by the National Center for Health Statistics at 89 survey locations between 1988 and 1994. The survey is designed to estimate the prevalence of common chronic conditions and associated risk factors for disease control and prevention. NHANES III was conducted from 1988 to 1994.[15] The sample for the survey was obtained through a complex multistage cluster design with oversampling of persons 60 years and older, non-Hispanic blacks, and Mexican Americans to enhance the precision of prevalence estimates in these groups.[16]

Our analysis used interview and laboratory data from 14,484 adult participants (age ≥ 18 years). Racial and ethnic grouping for the purpose of this study was by self-identification as white, African American or black, and Hispanic. Participants (593 persons) who self-identified as “other” were excluded from the analysis. All household incomes were expressed relative to the FPL for equally sized households.[15] FPL is 1 of 2 federal measures of poverty. The second measure is the poverty income ratio. The numerator in the poverty income ratio is the midpoint of the observed family income category in the Family Questionnaire variable HFF19R, and the denominator is the poverty threshold, age of the family reference person, and calendar year in which the family was interviewed. FPL is a simplification of the poverty threshold. The exact dollar amount is used to determine poverty status. It is issued each year by the Department of Health and Human Services. In this study, FPL is stratified as “poor or near poor” (<200% FPL) and “not poor” (>200% FPL).

Participants who reported ever being told that they have diabetes were considered to have diabetes for the purpose of this analysis, and those who reported taking medication for high blood pressure were considered to have hypertension. Race/ethnicity was self-identified. Urinary albumin excretion is defined as microalbuminuria when spot urinary albumin-creatinine ratio is 30 to 300 mg/d (20 to 200 μg/min) and as macroalbuminuria when spot urinary albumin-creatinine ratio exceeds 300 mg/d (>200 μg/min). Albuminuria was assessed by using a solid-phase fluorescent immunoassay with a sensitivity level of 0.05 mg/dL to measure urinary albumin, and the coefficient of variation ranged from 4.8% to 16.1% during the 6 years of the study.[17] There were 14,484 participants with a complete profile for analysis. Estimated glomerular filtration rate (GFR) was calculated by using the abbreviated Modification of Diet in Renal Disease Study equations as previously reported, with adjustment for serum creatinine (SCr)[13]:

$$\mathrm{GFR(mL/min/1.73m^2)} = \{186.3 \times \mathrm{SCr}^{-1.154} \times \mathrm{Age}^{-0.203}\} \times 0.742(\text{if female}) \times 1.210(\text{if African American})$$

Statistical Analysis

Characteristics of analysis samples are expressed in numbers for continuous variables and percentages for categorical variables. Univariate analyses were used to assess the association of poverty and other potential predictors with microalbuminuria and macroalbuminuria. Multivariate logistic regression was used to evaluate the independence of the association of poverty with both levels of albuminuria, with statistical adjustment for significant covariates identified in univariate analyses. Predictor variables of interest were retained in multivariate analyses regardless of their associated statistical significance in univariate analyses. Multivariate analyses were repeated for each level of albuminuria, with participants stratified by poverty levels and GFR to isolate the influence of each as a significant predictor of microalbuminuria and macroalbuminuria. Predictors that were not significant in multivariate analyses were not included in stratified multivariate analyses. Statistical adjustments were made in multivariate analyses for the use of medications associated with a substantial decrease (angiotensin- converting enzyme inhibitors or nondihydropyridine calcium channel blockers) or increase (dihydropyridine calcium channel blockers) in urinary protein excretion. Multivariate analyses included interaction terms for poverty and education, race and poverty, age and hypertension, and age and GFR. All statistically significant interaction terms were included in multivariate analysis. All analyses were performed using the Statistical Analysis System (version 8.0, 2000; SAS Institute, Cary, NC) and SUDAAN (version 8.0; Research Triangle Institute, Research Triangle Park, NC), with appropriate sampling weights to account for the complex survey design that includes oversampling for older age and minority status and to provide a nationally representative picture. *P* of 0.05 or less is considered statistically significant.

RESULTS

There were 6,850 men and 7,634 women 18 years and older in the analysis sample. Characteristics of the study population are listed in Table 1. Although there were more participants at less than the 200% FPL in the overall sample, black and Hispanic participants showed substantially greater proportions less than 200% FPL. Multivariate analyses included interaction terms for age and hypertension, as well as age and GFR. There were no statistically significant interactions between poverty and education or poverty and race. The significance of the predictor variables differed for both levels of albuminuria and GFR and is discussed under separate subheadings next.

FPL and Microalbuminuria

Poverty, defined as FPL less than 200%, was associated with microalbuminuria in both univariate and multivariate analyses. Age of 65 years or older, male sex, less than high school education, diabetes, hypertension, and decreased GFR remained independent covariates for microalbuminuria in multivariate analysis. Black race was not associated with microalbuminuria in univariate analysis, but when forced into the multivariate analysis, it became a significant covariate for microalbuminuria. Conversely, Hispanic race was associated with microalbuminuria in univariate analysis, but lost significance in multivariate analysis (Table 2). Although black race persisted in the multivariate model as an independent predictor of microalbuminuria, when the multivariate analysis was stratified by poverty level, the influence of this race was apparent among only the less affluent participants. Differences in relative odds for microalbuminuria across the strata defined by

FPL less than 200% and 200% or greater are listed in Table 3 for the covariates in our model.

FPL and Macroalbuminuria

Age of 65 years or older, racial/ethnic minority status, male sex, diabetes, hypertension, obesity, and decreased GFR remain important predictors for macroalbuminuria in both univariate and multivariate analyses. FPL less than 200% and less than high school education were not significant predictors for macroalbuminuria in the multivariate model (Table 4). When multivariate analysis is stratified by FPL less than 200% and 200% or greater, odds ratios (ORs) for macroalbuminuria were significantly greater for blacks and Hispanics compared with whites in the FPL-less-than-200% stratum. However, racial/ethnic differences in ORs for macroalbuminuria were attenuated for blacks and completely eliminated for Hispanics in the FPL-greater-than-200% stratum (Table 5).

FPL and Albuminuria Across GFR Levels

Adjusted ORs for both microalbuminuria and macroalbuminuria across GFR levels in our analyses are listed in Table 6. FPL less than 200% remained a significant predictor for microalbuminuria at a GFR of 60 mL/min or greater (≥1.00 mL/s; P = 0.0067), as were older age, male sex, black race, less than high school education, hypertension, and diabetes. At a GFR less than 60 mL/min (<1.00 mL/s), FPL less than 200% assumed a borderline level of significance as a predictor for microalbuminuria and black race was no longer a significant predictor of microalbuminuria. FPL less than 200% was not a significant predictor for macroalbuminuria at both levels of GFR. Black race was associated with macroalbuminuria at both levels of GFR, but for Hispanic race, only at a GFR less than 60 mL/min (<1.00 mL/s). Age older than 65 years, male sex, obesity, diabetes, and hypertension remained significant predictors of macroalbuminuria at a GFR of 60 mL/min or greater (≥1.00 mL/s). Age older than 65 years, obesity, and hypertension were not associated with macroalbuminuria at a GFR less than 60 mL/min (<1.00 mL/s) in our analysis.

DISCUSSION

Poverty has been linked to a number of adverse health outcomes, including CVD and CKD.[18–20] Mechanisms through which poverty may influence health include, but are not limited to, food insufficiency, greater exposure to environmental toxins, greater rates of infection and/or inflammation, increased levels of stress, lower rates of insurance, and access to quality health care.[21]

The excess prevalence of CKD and CVD in racial and ethnic minorities has been attributed, in part, to a wide variety of factors, including cultural lifestyle, SES, occupational and environmental exposures, and limited access to quality health care.[22–24] The understanding of the extent to which these factors influence and modify chronic disease risk profiles in racial and ethnic minorities will complement efforts to eliminate health disparities.

The separate assessment of the 2 levels of albuminuria, namely microalbuminuria and macroalbuminuria, in this study allows us to evaluate the influence of poverty on differences in the prevalence of a common clinical expression of early versus a more advanced stage of CKD. The association of poverty with microalbuminuria and not with macroalbuminuria in the multivariate model suggests that efforts directed at poverty are more likely to succeed early, rather than late, in the disease. The significantly greater adjusted OR for macroalbuminuria for black participants across both poverty levels supports the suggestion that the black race may have a unique susceptibility to excessive urinary albumin excretion.[25,26] Racial differences in renal vascular hemodynamic factors and susceptibility

to hypertension and diabetes have been shown to affect urinary albumin excretion rates and may contribute in part to the significantly greater odds of macroalbuminuria for black participants in this study.[27–29] Low birth weight also was associated with a decrease in nephron number, suggested to increase the risk for systemic and glomerular hypertension in adult life, as well as increase the risk for expression of renal disease after exposure to potentially injurious renal stimuli, thereby contributing to the excess prevalence of CVD and CKD in racial/ethnic minority populations.[30] The relatively lower OR (1.66 versus 1.98) for macroalbuminuria in this race at FPL of 200% or greater compared with FPL less than 200% highlights the compounding effect of poverty on whatever physiological risks there might be in this vulnerable population.

Results of our analyses for Hispanic participants further highlight the influence of poverty on the prevalence of albuminuria across race and ethnicity. Although there was no significant difference in ORs for microalbuminuria among Hispanic participants in comparison to whites across both poverty levels, ORs for macroalbuminuria were greater for Hispanic participants compared with whites at FPL less than 200%. This study suggests that poverty may account for some of the excess risk for albuminuria in racial/ethnic minority populations. Defining the magnitude and underlying mechanisms through which socioeconomic factors influence CKD in high-risk populations requires further investigation.

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Table 1

Characteristics of the Analysis Sample

Categories	Total	White	Black	Hispanic
Age (y)				
≥65	3,581 (24.72)	2,386 (36.98)	627 (15.41)	568 (14.34)
<65	10,903 (75.28)	3,443 (63.02)	3,443 (84.59)	3,394 (85.66)
Sex				
Male	6,850 (47.29)	3,029 (46.95)	1,839 (45.18)	1,982 (50.03)
Female	7,634 (52.71)	3,423 (53.05)	2,231 (54.82)	1,980 (49.97)
Poverty				
<200% FPL	7,468 (52.56)	2,111 (32.72)	2,573 (63.22)	2,784 (70.27)
≥200% FPL	7,016 (48.44)	4,341 (67.28)	1,497 (36.78)	1,178 (29.73)
Diabetes				
Yes	1,192 (8.24)	466 (7.23)	338 (8.31)	388 (9.82)
No	13,274 (91.76)	5,978 (92.77)	3,731 (91.69)	3,565 (90.18)
Hypertension				
Yes	4,007 (27.88)	1,959 (30.44)	1,264 (31.19)	784 (20.18)
No	10,367 (72.12)	4,477 (69.56)	2,789 (68.81)	3,101 (79.82)
Microalbuminuria				
Yes	1,884 (13.56)	849 (14.00)	570 (14.39)	465 (12.03)
No	12,008 (86.44)	5,217 (86.00)	3,391 (85.61)	3,400 (87.97)
Macroalbuminuria				
Yes	301 (2.17)	105 (1.73)	107 (2.70)	89 (2.30)
No	13,591 (97.83)	5,961 (98.27)	3,854 (97.30)	3,776 (97.70)
GFR (mL/min)				
≤60	958 (6.61)	685 (10.62)	181 (4.45)	92 (2.32)
>60	13,526 (93.39)	5,767 (89.38)	3,889 (95.55)	3,870 (97.68)
Body mass index (kg/m^2)				
≥30	3,646 (25.18)	1,366 (21.18)	1,232 (30.29)	1,048 (26.46)
<30	10,833 (74.82)	5,083 (78.87)	2,836 (69.71)	2,912 (73.54)
Education				
<High school	5,725 (39.72)	1,844 (28.68)	1,472 (36.39)	2,409 (61.16)
≥High school	8,689 (60.28)	4,586 (71.32)	2,573 (63.61)	1,530 (38.84)

NOTE. Values expressed as number (percent). To convert GFR in mL/min to mL/s, multiply by 0.01667.

Table 2

Univariate and Multivariate Analyses of Predictors for Microalbuminuria

	Univariate		Multivariate	
Predictor Variable (Reference Group)	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Black (white)	1.05 (0.93–1.17)	0.45	1.25 (1.10–1.43)	0.0009
Hispanic (white)	0.85 (0.75–0.96)	0.0067	1.06 (0.92–1.23)	0.44
Male (female)	1.14 (1.03–1.26)	0.0085	1.23 (1.11–1.37)	<0.0001
Age ≥ 65 y (<65 y)	3.44 (3.11–3.81)	<0.0001	2.71 (2.31–3.17)	<0.0001
FPL < 200% (≥200%)	1.35 (1.22–1.49)	<0.0001	1.18 (1.05–1.33)	0.0053
Diabetes yes (no)	4.66 (4.05–5.36)	<0.0001	2.98 (2.56–3.47)	<0.0001
Hypertension yes (no)	2.88 (2.61–3.19)	<0.0001	1.95 (1.68–2.27)	<0.0001
GFR ≤ 60 mL/min (>60 mL/min)	4.41 (3.75–5.18)	<0.0001	3.23 (2.08–5.04)	<0.0001
Body mass index ≥ 30 kg/m^2 (<30 kg/m^2)	1.28 (1.15–1.43)	<0.0001	1.06 (0.94–1.19)	0.37
Education < high school (≥high school)	1.64 (1.49–1.81)	<0.0001	1.15 (1.02–1.30)	0.019

NOTE. Adjusted for medication use (angiotensin-converting enzyme inhibitors, dihydropyridine and nondihydropyridine calcium channel blockers). OR = 1 for reference group. To convert GFR in mL/min to mL/s, multiply by 0.01667.

Abbreviation: CI, confidence interval.

Table 3

Multivariate Analysis for Microalbuminuria Stratified by Poverty Level

	Poverty < 200%		Poverty ≥ 200%	
Predictor Variable (Reference Group)	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Black (white)	1.33 (1.11–1.60)	0.0022	1.17 (0.96–1.42)	0.13
Hispanic (white)	1.13 (0.93–1.37)	0.22	0.95 (0.75–1.21)	0.70
Male (female)	1.16 (1.01–1.34)	0.0431	1.31 (1.12–1.52)	0.0009
Age ≥ 65 y (<65 y)	3.25 (2.64–4.01)	<0.0001	2.05 (1.64–2.57)	<0.0001
Diabetes yes (no)	2.67 (2.19–3.25)	<0.0001	3.46 (2.72–4.41)	<0.0001
Hypertension yes (no)	1.87 (1.53–2.30)	<0.0001	2.05 (1.64–2.57)	<0.0001
GFR ≤ 60 mL/min (>60 mL/min)	4.64 (2.44–8.82)	<0.0001	2.34 (1.23–2.47)	0.01
Body mass index ≥ 30 kg/m^2 (<30 kg/m^2)	1.05 (0.90–1.24)	0.52	1.07 (0.89–1.28)	0.50
Education < high school (≥high school)	1.16 (0.99–1.35)	0.06	1.13 (0.94–1.36)	0.20

NOTE. OR = 1 for reference group. To convert GFR in mL/min to mL/s, multiply by 0.01667.

*Adjusted for medication use (angiotensin-converting enzyme inhibitors, dihydropyridine and nondihydropyridine calcium channel blockers).

Table 4

Univariate and Multivariate Analyses of Predictors for Macroalbuminuria

	Univariate		Multivariate	
Predictor Variable (Reference Group)	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Black (white)	1.58 (1.20–2.07)	0.0011	1.80 (1.31–2.49)	0.0003
Hispanic (white)	1.34 (1.01–1.78)	0.0454	1.82 (1.29–2.58)	0.0007
Male (female)	1.71 (1.35–2.16)	<0.0001	2.22 (1.72–2.88)	<0.0001
Age ≥ 65 y (<65 y)	3.82 (3.03–4.80)	<0.0001	2.95 (1.93–4.52)	<0.0001
FPL < 200% (≥200%)	1.78 (1.40–2.26)	<0.0001	1.24 (0.94–1.65)	0.13
Diabetes yes (no)	9.93 (7.84–12.59)	<0.0001	4.57 (3.49–5.98)	<0.0001
Hypertension yes (no)	4.87 (3.84–6.19)	<0.0001	2.44 (1.65–3.61)	<0.0001
GFR ≤ 60 mL/min (>60 mL/min)	10.61 (8.29–13.59)	<0.0001	11.11 (6.53–18.90)	<0.0001
Body mass index ≥ 30 kg/m^2 (<30 kg/m^2)	2.13 (1.69–2.69)	<0.0001	1.75 (1.35–2.28)	<0.0001
Education < high school (≥high school)	2.61 (2.06–3.31)	<0.0001	1.29 (0.97–1.70)	0.07

NOTE. OR = 1 for reference group. To convert GFR in mL/min to mL/s, multiply by 0.01667.

*Adjusted for medication use (angiotensin-converting enzyme inhibitors, dihydropyridine and nondihydropyridine calcium channel blockers).

Table 5

Multivariate Analysis for Macroalbuminuria Stratified by Poverty Level

	Poverty < 200%		Poverty ≥ 200%	
Predictor Variable (Reference Group)	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Black (white)	1.98 (1.28–3.06)	0.0022	1.66 (1.01–2.73)	0.0454
Hispanic (white)	2.04 (1.29–3.20)	0.0021	1.43 (0.77–2.67)	0.26
Male (female)	2.32 (1.68–3.22)	<0.0001	2.10 (1.36–3.24)	0.0008
Age ≥ 65 y (<65 y)	2.76 (1.62–4.69)	0.0002	3.12 (1.52–6.39)	0.0019
Diabetes yes (no)	5.36 (3.82–7.50)	<0.0001	3.43 (2.16–5.44)	<0.0001
Hypertension yes (no)	2.44 (1.50–3.99)	0.0004	2.35 (1.22–4.55)	0.0111
GFR ≤ 60 mL/min (>60 mL/min)	10.67 (5.54–20.56)	<0.0001	10.39 (4.03–26.78)	<0.0001
Body mass index ≥ 30 kg/m^2 (<30 kg/m^2)	1.56 (1.12–2.19)	0.0089	2.21 (1.44–3.40)	0.0003
Education < high school (≥high school)	1.25 (0.86–1.80)	0.24	1.39 (0.90–2.14)	0.13

NOTE. OR = 1 for reference group. To convert GFR in mL/min to mL/s, multiply by 0.01667.

*Adjusted for medication use (angiotensin-converting enzyme inhibitors, dihydropyridine and nondihydropyridine calcium channel blockers).

Table 6

Multivariate Analysis of Predictors of Proteinuria by GFR

	GFR < 60 mL/min		GFR ≥ 60 mL/min	
Predictor Variable (Reference Group)	**OR (95% CI)**	***P***	**OR (95% CI)**	***P***
Microalbuminuria				
Black (white)	1.11 (0.71–1.76)	0.64	1.25 (1.09–1.44)	0.0016
Hispanic (white)	1.38 (0.71–2.71)	0.35	1.04 (0.89–1.21)	0.62
Male (female)	1.58 (1.12–2.23)	0.0092	1.20 (1.07–1.34)	0.0016
Age ≥ 65 y (<65 y)	1.42 (0.62–3.26)	0.41	2.70 (2.29–3.19)	<0.0001
Diabetes yes (no)	2.72 (1.78–4.17)	<0.0001	3.03 (2.57–3.57)	<0.0001
Hypertension yes (no)	2.62 (1.01–6.82)	0.0479	1.90 (1.63–2.22)	<0.0001
FPL < 200% (≥200%)	1.14 (0.80–1.63)	0.47	1.19 (1.05–1.35)	0.0054
Body mass index ≥ 30 kg/m^2 (<30 kg/m^2)	0.57 (0.38–0.86)	0.0076	1.13 (1.00–1.28)	0.06
Education < high school (≥high school)	1.03 (0.72–1.46)	0.88	1.17 (1.03–1.32)	0.0148
Macroalbuminuria				
Black (white)	2.11 (1.17–3.82)	0.0136	1.61 (1.10–2.35)	0.0137
Hispanic (white)	4.96 (2.57–9.58)	<0.0001	1.30 (0.86–1.96)	0.21
Male (female)	2.56 (1.59–4.14)	0.0001	2.06 (1.51–2.81)	<0.0001
Age ≥ 65 y (<65 y)	0.84 (0.27–2.66)	0.77	2.86 (1.80–4.54)	<0.0001
Diabetes yes (no)	2.47 (1.53–3.98)	0.0002	5.90 (4.26–8.17)	<0.0001
Hypertension yes (no)	1.93 (0.58–6.45)	0.28	2.30 (1.51–3.51)	0.0001
FPL < 200% (≥200%)	1.03 (0.61–1.73)	0.91	1.33 (0.94–1.88)	0.11
Body mass index ≥ 30 kg/m^2 (<30 kg/m^2)	1.25 (0.74–2.11)	0.41	2.05 (1.50–2.80)	<0.0001
Education < high school (≥high school)	1.25 (0.76–2.07)	0.38	1.29 (0.92–1.81)	0.14

NOTE. OR = 1 for reference group. To convert GFR in mL/min to mL/s, multiply by 0.01667.

* Adjusted for medication use (angiotensin-converting enzyme inhibitors, dihydropyridine and nondihydropyridine calcium channel blockers).