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Ethnic Differences in the Development of Albuminuria: The DISTANCE Study

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Abstract

Objectives—To determine whether ethnic differences in the incidence of albuminuria are present in patients with diabetes, and to identify social, behavioral, and provider factors that explain ethnic differences.

Study Design—Survey follow-up design with a race-stratified baseline survey (2005–2006) in diabetic patients from a nonprofit, fully integrated healthcare system in Northern California. We followed the 10,596 respondents (30% whites, 20% blacks, 23% Hispanics, 14% Asians, and 13% Filipinos) without evidence of prevalent albuminuria at baseline.

Methods—Incident albuminuria was defined by positive dipstick urinalysis (≥1) or urine albumin to creatinine level (≥30 mg/g), and confirmed with repeat testing at least 3 months later.

Results—The 27,292 person-years of observation yielded 981 incident albuminuria events. Age-standardized rates of albuminuria (per 1000 person-years) ranged from 13.6 (95% confidence interval [CI] 10.5–17.0) in whites to 27.8 (CI 18.2–38.3) in blacks. In fully adjusted Cox models, the hazard ratio for blacks (1.22, 95% CI 1.09–1.38), Asians (1.35, 95% CI 1.13–1.61), and Filipinos (1.93, 95% CI 1.61–2.32), but not Hispanics, was significantly greater than it was for whites. In some cases, point estimates changed markedly from the base model when fully adjusted for potential confounders. Moreover, adjustment for an array of potentially mediating factors explained only a small proportion of the observed ethnic disparities.

Conclusions—Despite uniform medical care coverage, Filipinos, blacks, and Asians with diabetes developed albuminuria at higher rates than white and Hispanic adults.

Diabetes afflicts 8% of the US population, and its prevalence is expected to double over the next 2 decades.[1] Diabetes is at least 2 to 4 times more common among ethnic minorities

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than it is among non-Hispanic whites.[2] Furthermore, minorities have higher mortality rates and microvascular complications of diabetes, such as end-stage renal disease (ESRD).[3] Collectively, these statistics have placed diabetes at the center of the president's Healthy People 2020 initiative to eliminate health disparities.[4]

Albuminuria is an extremely common consequence of diabetes, with a prevalence of 30% to 50%.[5] Microalbuminuria and macroalbuminuria are strongly associated with angiographically determined coronary atherosclerosis, cardiovascular events, kidney failure, and mortality in patients with diabetes, as well as in the general population, independent of conventional cardiovascular risk factors and the estimated glomerular filtration rate (eGFR).[6,7] Although the natural history of diabetic nephropathy is relatively well described, prior studies have rarely examined ethnic variations in the development of albuminuria or identified factors that may explain ethnic differences in the risk of incident albuminuria. The majority of work in this field has focused on ESRD, for which ethnic disparities are established.[3] However, ESRD patients represent less than 1% of the diabetic population; therefore, strategies targeting ESRD are limited to a small subset of patients.[8] Understanding ethnic differences in rates of albuminuria and the underlying causes for these differences is likely to advance public health objectives for diabetes treatment, because albuminuria is very common and is strongly associated with adverse events, and kidney disease is the complication of diabetes with the greatest effect on minority groups.[3,7]

We conducted a prospective, longitudinal cohort study to evaluate ethnic differences in incident albuminuria in a fully insured, ethnically diverse, well-characterized cohort of diabetic patients. Our secondary goal was to identify social, behavioral, and provider-level factors that could explain observed ethnic differences in albuminuria in this population.

MATERIALS AND METHODS

Overview

The Diabetes Study of Northern California (DISTANCE) is a National Institute of Diabetes and Digestive and Kidney Diseases–sponsored study of diabetes conducted at Kaiser Permanente Northern California (Kaiser).[9] This nonprofit, integrated group practice provides comprehensive healthcare to an ethnically diverse population of more than 3 million people, approximately 30% of the population of Northern California. The DISTANCE cohort comprised an ethnically stratified, random sample of diabetic patients (type 1 and type 2) receiving care from Kaiser. In 2005 to 2006, participants of DISTANCE completed a detailed assessment of demographic, clinical, behavioral, socioeconomic, psychosocial, medical knowledge, and quality of care indicators (62% survey response rate). The complete survey is available at www.distancesurvey.org. The survey was offered in multiple languages including English, Spanish, Cantonese, Mandarin, and Tagalog using certified translations of an English script, and through multiple modalities, including computer-assisted telephone interview, self-administered written format, and the Internet, to maximize accessibility of the survey.

Survey data were supplemented with clinical information from the Kaiser electronic medical record that comprehensively captures inpatient and outpatient utilization, laboratory testing, clinical measurements (blood pressure, height, and weight), pharmacy data (including prescribed medications and filled prescriptions), processes of care, procedures, and diagnoses. Patient data are linked to the California Death Registry to ascertain death information and the United States Renal Data System for ESRD status.[8] Neighborhood socioeconomic status was determined by linkage of participant residential addresses with the year 2000 US Census data at the census-tract level.

Participants

We included all DISTANCE participants who self-identified their ethnicity as white (non-Hispanic), black (non-Hispanic), Hispanic, Asian, or Filipino. All individuals entered the study at the time of survey (index date). We excluded (1) participants belonging to other ethnic groups, those who were multiethnic, or those with missing ethnicity; (2) those without continuous membership at Kaiser (allowing <3 months' gap); (3) individuals with prevalent albuminuria, defined as microalbuminuria measured on any urine dipstick testing (≥1) or urine albumin to creatinine ratio (≥30 mg/g) within 2 years prior to the index date; (4) patients with ESRD (defined as receipt of chronic dialysis therapy or kidney transplantation)[10]; and (5) participants who did not have an additional measurement of albuminuria (urinary albumin excretion or urine dipstick testing) after the index date.

Outcome

The primary outcome for the analysis was time from study entry to incident albuminuria. Albuminuria was defined according to National Kidney Foundation guidelines as having urinary albumin excretion levels at or above the threshold for "microalbuminuria" (≥1 on dipstick testing or ≥30 mg/g on urine albumin to creatinine ratio testing), confirmed on a second consecutive occasion at least 3 months later. The first positive urine test result was used at the date of censor (ie, microalbuminuria incidence date).

Variables

Self-reported ethnicity, our primary predictor, was categorized as white, black, Asian, Hispanic, or Filipino. Filipinos were not included in the Asian category given the unique social, cultural, and linguistic characteristics of this group.[11] All baseline covariates were derived from the DISTANCE survey or the electronic medical record, using validated algorithms based on laboratory, vital sign, and clinical data closest to the survey date and within the preceding 2 years.[3,9,12] We included demographics (age, sex); clinical characteristics (blood pressure, low-density lipoprotein, glycosylated hemoglobin [A1C], body mass index, eGFR); comorbid conditions (hypertension, hyperlipidemia); macrovascular disease (heart failure, coronary heart disease, peripheral vascular disease, or cerebrovascular accident); microvascular disease (retinopathy); diabetes characteristics (diabetes duration, receipt of insulin therapy); and current treatment (angiotensin-converting enzyme inhibitor or angiotensin receptor blocker). We calculated eGFR using the Modification of Diet in Renal Disease formula based on age, sex, race, and standardized serum creatinine.[13]

We also selected variables that could be potential mediators of ethnic differences in the development of albuminuria based on the Institute of Medicine's definition of disparities as the difference in treatment or access not justified by the differences in health status or preferences of the groups.[14] These included socioeconomic factors (education [highest degree attained], income, and neighborhood deprivation index[15]); language (limited English proficiency and nativity); behaviors (smoking status [current, never, past], adequate exercise [by self-report], self-monitoring of blood glucose levels, and adherence [oral diabetes medication adherence and antihypertensive adherence over the prior year]); and provider factors (poor provider communication,[16] patient/provider race and sex concordance). The closed pharmacy system at Kaiser provides near-complete ascertainment of pharmacy utilization and facilitates assessment of medication adherence. We also adjusted relevant clinical factors including use of lipid-lowering and antihypertensive medications (and initiation of new treatments during follow-up), change in systolic blood pressure, change in A1C, and a validated index of medication adherence, "Continuous, multiple-interval measure of medication gaps," which estimates the percentage of days during follow-up without adequate supply of medications.[17]

Statistical Analysis

We calculated age-standardized rates of incident albuminuria assuming a Poisson distribution. We estimated the adjusted risk of albuminuria using a Cox proportional hazards model. For all analyses, we incorporated expansion weighting in all models to accommodate the nonproportional sampling fractions used for the race-stratified random sampling design of the DISTANCE survey. Patients were followed from the index date and censored at the time of de-enrollment from Kaiser, death, or the end of follow-up (December 31, 2008). We compared the relative hazard for incident albuminuria associated with ethnicity using white race as the referent group. Multivariable Cox models were adjusted for all covariates described above and listed in Table 1. We also investigated possible interactions between ethnicity and age, sex, microvascular disease, exposure to angiotensin-converting enzyme inhibitors or angiotensin receptor blockers, blood pressure, body mass index, and eGFR in fully adjusted Cox models. The *P* values for interactions were obtained using cross products between ethnicity with each variable of interest. We performed Markov chain Monte Carlo multiple imputation using 20 imputations to account for missing data.[18] We specified serial, nested models to identify potential mediator domains that may explain ethnic differences in the albuminuria incidence by sequentially adding groups of related candidate mediators to the fully adjusted base model.

Diabetes care at Kaiser is largely consistent with the recommendations of the American Diabetes Association, which advises annual testing for albuminuria. To assess adherence with these guidelines and to determine whether ascertainment of the outcome occurred uniformly across ethnic groups, we compared the frequency of albuminuria testing in the cohort by ethnicity. In a supplemental analysis, we compared the incidence of albuminuria in DISTANCE survey responders with the incidence in survey nonresponders by ethnic group to evaluate the potential for selection bias due to survey nonresponse. Model assumptions of Cox proportional hazards models were checked by comparing plots of log (−log[survival]) versus log of survival time and the Schoenfeld test. All analyses were conducted using SAS version 9.2 (SAS Institute, Inc, Cary, North Carolina). This study was approved by the institutional review board of the Kaiser Foundation Research Institute.

RESULTS

In total, 20,030 subjects responded to the DISTANCE survey and maintained continuous membership at Kaiser. We excluded 3629 individuals with self-reported multiethnic, other, or unknown ethnicity, 306 persons with ESRD, 4984 participants with prevalent albuminuria, and 515 participants with no albuminuria measurement, leaving a total of 10,596 persons in the analytic cohort. Ethnic minorities were well represented, with a relatively balanced proportion of women within each group (Table 1). The majority of patients were older, with a mean age of approximately 60 years, and 70% to 95% had diagnosed hypertension or hyperlipidemia. A larger proportion of Hispanics, Filipinos, and blacks had A1C levels of >8% compared with whites and Asians. In contrast, Hispanics, Asians, and Filipinos had better blood pressure control compared with whites and blacks (marked by a systolic blood pressure of <130 mg Hg). At baseline, approximately 15% to 25% of the cohort had moderate impairment of kidney function (eGFR <60 mL/min per 1.73 m^2) without albuminuria; the highest prevalence of reduced GFR was observed in whites.

Asians, Filipinos, and whites had higher levels of socioeconomic status than blacks and Hispanics based on annual income levels greater than $65,000, college education, and lower levels of neighborhood deprivation. Limited English proficiency was common in Hispanics, Asians, and Filipinos; the vast majority of Filipinos and a large proportion of Asians and Hispanics were not born in the United States. Poor provider communication was more commonly reported by Filipinos and Hispanics than by whites, blacks, and Asians.

There were 981 confirmed incident albuminuria events over 3 years of observation (27,292 person-years of observation). In all, 11% of blacks, 10% of Filipinos, 9% of Asians and Hispanics, and 8% of whites developed albuminuria. The mean observation time and the number of albuminuria measurements per individual appeared to be comparable across ethnic groups (Table 2). Seventy percent of the diagnoses were based on 2 positive confirmatory tests (either albumin to creatinine ratio or 24-hour urinary protein); 22% were based on a combination of a dipstick plus either albumin to creatinine ratio or 24-hour urinary protein; and 8% were based on 2 positive dipstick tests (ie, dipstick only). On average, the second (confirmatory) test occurred 9.2 months (SD 5.6 months) after the first positive test. The age-standardized rate of albuminuria (per 1000 person-years) was highest in blacks (27.8, 95% confidence interval [CI] 18.2–38.3), and the CIs did not overlap with those for the reference group (whites: 13.6, 95% CI 10.5–17.0). The confidence intervals did overlap between those for whites and the remaining race groups: Filipinos (22.0, 95% CI 14.0–31.1), Asians (15.0, 95% CI 7.7–23.4), and Hispanics (13.8, 95% CI 11.6–16.2). In fully adjusted models, we observed a 93% greater risk of albuminuria in Filipinos, a 35% greater risk in Asians, and a 22% greater risk in blacks compared with whites.

We also attempted to identify potential mediators of the elevated risk of incident albuminuria associated with ethnicity (Table 3). Hazard ratios were only slightly attenuated for blacks, changed minimally in Hispanics, and strengthened in Asians and Filipinos. In the final saturated model that included all 34 factors, the risk of albuminuria associated with Asian and Filipino ethnicity increased relative to the base model, particularly when clinical factors were introduced to the model. In supplemental analyses, incidence rates of albuminuria were similar in survey nonrespondents in DISTANCE, as well as in the larger Kaiser Permanente Northern California Diabetes Registry, suggesting selection bias was not a major concern.

DISCUSSION

To our knowledge, this study is the first to document ethnic differences in the incidence of albuminuria among patients with diabetes. In this large, ethnically diverse, well-characterized cohort of diabetic patients receiving relatively uniform healthcare, we found that the fully adjusted risk of albuminuria was 22%, 35%, and 93% greater in blacks, Asians, and Filipinos compared with whites. Only Hispanics were not at significantly elevated risk relative to whites. We also tested a wide spectrum of factors that were hypothesized to explain observed ethnic disparities. Despite extensive adjustment for these candidate mediator variables, we were unable to explain a substantive proportion of the differences we observed between ethnic groups. In fact, model adjustment accentuated differences between the white reference group and Asians and Filipinos. Inflation of effect estimates in response to adjustment is the opposite of what would be expected if the included variables were explanatory. Alternatively, the crude estimates could have underestimated true effect size due to “negative confounding.” This might occur if Asians and Filipinos had a higher-than-expected observed incidence of albuminuria after accounting for observed racial differences in variables that were strongly predictive overall (eg, worse blood pressure, glycemic control, lower GFR, congestive heart failure). It is also possible that ethnic differences in the risk of albuminuria may be attributable to unmeasured, underlying genetic or biologic differences; long-term exposures to poor risk factor control; or other environmental factors not measured in this study.

Comparison With Previous Literature

It is a common assumption that ethnic differences in diabetic nephropathy have been well characterized. While it is known that ethnic minorities with diabetes experience accelerated rates of ESRD compared with whites, no previous studies have examined ethnic differences

in the development of albuminuria. Prior work in this area has been limited to studies that were cross-sectional in design,[19–21] focused on changes in serum creatinine[22] or the provision of dialysis or kidney transplantation,[3] or lacked adequate representation of ethnic minorities.[23] The results of our longitudinal analyses are consistent with cross-sectional findings from the National Health and Nutrition Examination Survey as well as the Pathways Study, which found a higher prevalence of albuminuria in ethnic minorities compared with whites.[19,24] Our study builds on these observations by extending them to a much larger number of patients, particularly Asians and Hispanics, and strengthening the causal interpretation of the association between ethnicity and albuminuria, by virtue of the prospective cohort design of the current study.

Clinical Implications

It is notable that the majority of research aimed at reducing ethnic disparities in diabetic kidney disease has focused on the risk of ESRD. While interventions aimed at curbing ESRD attributable to diabetic nephropathy are needed, we speculate that public health approaches that target albuminuria are more likely to reach a larger number of individuals and thus have a greater impact on ethnic disparities. Albuminuria affects up to 50% of patients with diabetes, while eGFR <60 mL/min per 1.73 m^2 is present in 14%, and ESRD occurs in <1%.[5] In addition, any degree of albuminuria, determined either by dipstick urinalysis or urine albumin to creatinine ratio, appears to be as strong an indicator as kidney function for identifying patients at risk for both progressive kidney disease and adverse cardiovascular events.[7,25] Based on this information, the National Kidney Foundation—Kidney Disease: Improving Global Outcomes initiative plans to formally include grading of albuminuria levels in the consensus guidelines for staging of chronic kidney disease, with clinical recommendations for each stage, including those aimed at prevention. It will be important for future research to evaluate how implementation of new guidelines impacts ethnic disparities in diabetes-related outcomes.

Explanatory Factors

The secondary goal of this study was to identify the underlying determinants of the observed ethnic differences in the incidence of albuminuria. All participants had regular ambulatory diabetes care in an integrated healthcare system providing uniform access to medications and services. Despite similar access to care, ethnic differences in the risk of albuminuria were substantial. We tested a large number of factors hypothesized to contribute to diabetes complications in prior studies. In spite of this, we were unable to identify factors that substantially explained observed ethnic differences. While we thoroughly investigated clinical differences between ethnic groups, social factors, and inequalities in the receipt of healthcare, it is possible that relevant factors were not included in this analysis. In addition, long-term exposures to elevated A1C and poorly controlled hypertension, which were not captured in these data, may play an important role. Genetic factors have been widely recognized in renal disease (eg, APOL1 and MYH9), and may play an important role in the residual differences in albuminuria observed in this study.[26,27]

Strengths and Limitations

Study strengths include the large sample population, balanced representation across multiple ethnic groups, and uniform ascertainment of a wide range of patient factors collected within an integrated healthcare setting. Results should be generalizable to other insured, treated diabetic populations. Although dipstick urinalysis is a semiquantitative method that has less favorable diagnostic properties than urine albumin to creatinine ratio for the assessment of albuminuria, it is widely used in clinical practice, is considerably less expensive, and provides similar information for prognosis and risk stratification.[7,25] However, the 2 methods and cut-points (albumin to creatinine ratio of ≥30 mg/g or positive result on

dipstick [≥1]) may not be fully comparable or used at random. A further strength of this study is the ability to confirm the presence of albuminuria with repeated measurement over a 3-month period, as currently recommended by National Kidney Foundation guidelines.[28] Transient proteinuria or decreases in GFR are common in clinical practice and may decrease the specificity of such outcomes in cohort studies, which typically ascertain the outcome at a single time point. However, we also relied on an electronic medical record and automated databases for outcomes surveillance in a usual care setting, for which the timing of measurements is determined by the healthcare provider, in contrast to repeated visits by participants at set time points. Annual screening for diabetic nephropathy through urine dipstick or albumin to creatinine testing is currently the standard of care in diabetes within the Kaiser medical system. In addition, we found that the frequency and timing of albuminuria testing were relatively similar between ethnic groups. Another limitation is that the measured covariates may differ biologically between race groups; for example, A1C levels differ between African Americans and whites despite similar serum glucose levels. While we adjusted for the duration of diabetes, this variable was based on time since first diagnosis. Although differences in the duration across ethnic groups were minimal, it is possible that the subjects had undiagnosed diabetes for differing lengths of time.

CONCLUSIONS

This is the first study to date which documents ethnic disparities in the risk of albuminuria in patients with diabetes. Notably, the observed differences between ethnic groups did not appear to be fully explained by a host of clinical, socioeconomic, behavioral, or provider factors or by access to care. Albuminuria is a potent predictor of future microvascular and macrovascular complications; therefore, these results may have clinical implications for risk-stratifying patients with diabetes and guiding efforts to reduce ethnic disparities in diabetes.

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Take-Away Points

Despite uniform medical care coverage, Filipinos, blacks, and Asians with diabetes developed albuminuria at higher rates than whites.

- After adjustment for confounding, the incidence of albuminuria was 93% greater in Filipinos, 35% greater in Asians, and 22% higher in blacks compared with whites; the difference between Hispanics and whites was not significant.
- Racial differences were not explained by a wide range of potentially mediating factors.
- Albuminuria is a potent predictor of future microvascular and macrovascular complications; thus, these findings have clinical implications for risk stratification and future efforts to reduce ethnic disparities in renal disease.

Table 1

Baseline Characteristics of 10,596 Participants in the Diabetes Study of Northern California[a]

Characteristic	White	Black	Hispanic	Asian	Filipino
No. (%)	3133 (29.6)	2146 (20.2)	2402 (22.7)	1499 (14.1)	1416 (13.4)
Age, y, mean (SD)	59.8 (10.1)	59.7 (9.8)	56.9 (10.9)	60.4 (9.8)	58.6 (9.1)
Female	1408 (44.9)	1278 (59.6)	1313 (54.7)	715 (47.7)	782 (55.2)
Diagnosed conditions					
Hypertension	2407 (76.8)	1850 (86.2)	1642 (68.4)	1079 (72.0)	1116 (78.8)
Cardiovascular disease	538 (17.2)	332 (15.5)	261 (10.9)	174 (11.6)	171 (12.1)
Heart failure	41 (1.3)	59 (2.8)	22 (0.9)	6 (0.4)	12 (0.9)
Hyperlipidemia	2891 (92.3)	1970 (91.8)	2169 (90.3)	1392 (92.9)	1352 (95.5)
Diabetes characteristics					
Insulin therapy	748 (23.9)	534 (24.9)	427 (17.8)	196 (13.1)	137 (9.7)
ACEI/ARB therapy	2291 (73.1)	1622 (75.6)	1613 (67.2)	1037 (69.2)	1042 (73.6)
Self-monitoring of blood glucose	1571 (50.1)	1041 (48.5)	1100 (45.8)	677 (45.2)	658 (46.5)
Diabetes duration, y, mean (SD)	10.0 (9.4)	10.1 (8.3)	9.3 (7.9)	9.8 (9.2)	8.8 (7.4)
Diabetes duration					
0–9 y	1953 (62.4)	1242 (57.9)	1508 (62.8)	929 (62.0)	923 (65.2)
10–19 y	781 (24.9)	652 (30.4)	649 (27.0)	410 (27.3)	377 (26.6)
≥20 y	382 (12.2)	248 (11.5)	227 (9.5)	153 (10.2)	108 (7.6)
Missing	17 (0.5)	4 (0.2)	18 (0.7)	7 (0.5)	8 (0.6)
A1C, %, mean (SD)	7.1 (1.3)	7.5 (1.7)	7.5 (1.6)	7.1 (1.1)	7.4 (1.3)
A1C					
<7%	1749 (55.8)	1033 (48.1)	1057 (44.0)	802 (53.5)	629 (44.4)
7–<8%	800 (25.5)	544 (25.4)	619 (25.8)	460 (30.7)	445 (31.4)
8–<10%	456 (14.6)	377 (17.6)	493 (20.5)	202 (13.5)	268 (18.9)
≥10%	117 (3.7)	181 (8.4)	222 (9.2)	31 (2.1)	72 (5.1)
Missing	11 (0.4)	11 (0.5)	11 (0.5)	4 (0.2)	2 (0.1)
Clinical measurements					
Systolic blood pressure					

Characteristic	White	Black	Hispanic	Asian	Filipino
<130 mm Hg	1569 (50.1)	1025 (47.8)	1393 (58.0)	967 (64.5)	867 (61.2)
≥130 mm Hg	1486 (47.4)	1098 (51.1)	981 (40.8)	509 (34.0)	534 (37.7)
Missing	78 (2.5)	23 (1.1)	28 (1.2)	23 (1.5)	15 (1.1)
Initiated new blood pressure medications during follow-up	1268 (40.5)	966 (45.0)	916 (38.1)	517 (34.5)	525 (37.1)
Body mass index					
<25 kg/m2	359 (11.5)	212 (9.9)	198 (8.2)	630 (42.0)	502 (35.5)
25–29 kg/m2	891 (28.4)	624 (29.1)	820 (34.2)	579 (38.6)	622 (43.9)
30–35 kg/m2	833 (26.6)	588 (27.4)	690 (28.7)	178 (11.9)	188 (13.3)
>35 kg/m2	932 (29.7)	640 (29.8)	618 (25.7)	66 (4.4)	64 (4.5)
Missing	118 (3.8)	82 (3.8)	76 (3.2)	46 (3.1)	40 (2.8)
LDL, mg/dL, mean (SD)	93.5 (27.8)	98.1 (29.0)	94.5 (27.9)	89.2 (25.6)	91.0 (26.1)
LDL					
<100 mg/dL	2049 (65.4)	1258 (58.6)	1512 (63.0)	1080 (72.0)	996 (70.3)
≥100 mg/dL	1063 (33.9)	871 (40.6)	865 (36.0)	415 (27.7)	417 (29.5)
Missing	21 (0.7)	17 (0.8)	25 (1.0)	4 (0.3)	3 (0.2)
Use of lipid-lowering medications	2501 (79.8)	1633 (76.1)	1750 (72.9)	1180 (78.7)	1205 (85.1)
GFR, mL/min per 1.73 m, mean (SD)	69.3 (16.7)	76.0 (19.2)	78.5 (18.4)	72.4 (15.4)	71.8 (16.1)
Baseline GFR					
≥90 mL/min per 1.73 m^2	311 (9.9)	458 (21.3)	634 (26.4)	191 (12.7)	197 (13.9)
60–89 mL/min per 1.73 m^2	1849 (59.0)	1243 (57.9)	1358 (56.5)	974 (65.0)	887 (62.6)
45–59 mL/min per 1.73 m^2	685 (21.9)	312 (14.5)	280 (11.7)	249 (16.6)	249 (17.6)
<45 mL/min per 1.73 m^2	186 (5.9)	100 (4.7)	72 (3.0)	48 (3.2)	65 (4.6)
Missing	102 (3.3)	33 (1.5)	58 (2.4)	37 (2.5)	18 (1.3)
Socioeconomic factors					
Income					
≤$14,999	161 (5.1)	205 (9.6)	282 (11.7)	172 (11.5)	109 (7.7)
$15,000–$24,999	203 (6.5)	154 (7.2)	257 (10.7)	97 (6.5)	82 (5.8)
$25,000–$34,999	314 (10.0)	228 (10.6)	334 (13.9)	99 (6.6)	143 (10.1)
$35,000–$64,999	826 (26.4)	660 (30.8)	671 (27.9)	320 (21.3)	342 (24.1)

Characteristic	White	Black	Hispanic	Asian	Filipino
≥$65,000	1287 (41.1)	619 (28.8)	544 (22.7)	564 (37.6)	542 (38.3)
Missing	342 (10.9)	280 (13.0)	314 (13.1)	247 (16.5)	198 (14.0)
Education					
No degree earned	345 (11.0)	229 (10.7)	817 (34.0)	187 (12.5)	47 (3.3)
High school/GED	998 (31.9)	716 (33.4)	705 (29.3)	317 (21.1)	217 (15.3)
Some college	784 (25.0)	670 (31.2)	544 (22.7)	316 (21.1)	281 (19.9)
College graduate/postgraduate	964 (30.8)	499 (23.2)	244 (10.2)	653 (43.6)	851 (60.1)
Missing	42 (1.3)	32 (1.5)	92 (3.8)	26 (1.7)	20 (1.4)
Neighborhood deprivation index					
1st quartile	917 (29.3)	380 (17.7)	353 (14.7)	610 (40.7)	314 (22.2)
2nd quartile	800 (25.5)	368 (17.2)	486 (20.2)	446 (29.7)	446 (31.5)
3rd quartile	653 (20.9)	516 (24.0)	597 (24.9)	282 (18.8)	428 (30.2)
4th quartile	386 (12.3)	844 (39.3)	826 (34.4)	136 (9.1)	199 (14.1)
Missing	377 (12.0)	38 (1.8)	140 (5.8)	25 (1.7)	29 (2.0)
Social factors					
Limited English proficiency	133 (4.3)	120 (5.6)	1001 (41.7)	644 (43.0)	383 (27.1)
Nativity (born in the United States)	2869 (91.6)	2053 (95.7)	1194 (49.7)	513 (34.2)	60 (4.2)
Behaviors					
Smoking					
Nonsmoker	1528 (48.8)	1107 (51.6)	1518 (63.2)	1061 (70.8)	982 (69.3)
Current smoker	248 (7.9)	236 (11.0)	155 (6.5)	49 (3.3)	85 (6.0)
Former smoker	1317 (42.0)	791 (36.9)	697 (29.0)	361 (24.1)	331 (23.4)
Missing	40 (1.3)	12 (0.5)	32 (1.3)	28 (1.8)	18 (1.3)
Exercise					
Insufficiently active	1524 (48.7)	1212 (56.5)	1226 (51.0)	800 (53.4)	810 (57.2)
Sufficiently active	461 (14.7)	347 (16.2)	365 (15.2)	254 (16.9)	221 (15.6)
Highly active	1148 (36.6)	587 (27.3)	811 (33.8)	445 (29.7)	385 (27.2)
Medication adherence					
Antihypertensives					

Characteristic	White	Black	Hispanic	Asian	Filipino
≥80% adherence	2293 (73.2)	1651 (76.9)	1347 (56.1)	999 (66.6)	984 (69.5)
<80% adherence	329 (10.5)	245 (11.4)	446 (18.6)	165 (11.0)	184 (13.0)
Not prescribed	511 (16.3)	250 (11.7)	609 (25.3)	335 (22.4)	248 (17.5)
Oral hypoglycemics					
≥80% adherence	1919 (61.3)	1282 (59.7)	1419 (59.1)	989 (66.0)	989 (69.9)
<80% adherence	414 (13.2)	384 (17.9)	494 (20.6)	183 (12.2)	217 (15.3)
Not prescribed	800 (25.5)	480 (22.4)	489 (20.3)	327 (21.8)	210 (14.8)
Provider factors					
Poor provider communication	515 (16.4)	396 (18.5)	584 (24.3)	274 (18.3)	399 (28.2)
Provider discrimination	76 (2.4)	103 (4.8)	139 (5.8)	71 (4.7)	70 (4.9)
Sex concordance	1947 (62.1)	1272 (59.3)	1460 (60.8)	902 (60.2)	883 (62.4)
Race concordance	1526 (48.7)	210 (9.8)	310 (12.9)	986 (65.8)	813 (57.4)

A1C indicates glycosylated hemoglobin; ACEI/ARB, angiotensin-converting enzyme inhibitor/angiotensin II receptor blocker; GED, general education development; GFR, glomerular filtration rate; LDL, low-density lipoprotein; SD, standard deviation.

[a]Values are number (percentage) unless indicated otherwise.

Table 2

Association of Ethnicity With Incident Albuminuria

Variable	White (n = 3133)	Black (n = 2146)	Hispanic (n = 2402)	Asian (n = 1499)	Filipino (n = 1416)
Albuminuria events	260	239	207	130	145
Total observation time, person-years	8364	5490	6054	3895	3489
Observation time per individual, y, mean (SD)	2.7 (0.8)	2.6 (0.8)	2.5 (0.7)	2.6 (0.7)	2.5 (0.8)
Albuminuria measurements per individual, mean (SD)	4.4 (3.3)	4.4 (3.9)	4.3 (3.4)	3.9 (3.2)	3.8 (2.5)
Age-standardized rate[a]	13.6 (10.5–17.0)	27.8 (18.2–38.3)	13.8 (11.6–16.2)	15.0 (7.7–23.4)	22.0 (14.0–31.1)

SD indicates standard deviation.

[a]Rates are reported as albuminuria events per 1000 person-years (95% confidence interval).

Table 3

Effect of Adjustment for Potential Mediators on the Association Between Ethnicity and Incident Albuminuria

	Hazard Ratio (95% Confidence Interval)				
Model	**White**	**Black**	**Hispanic**	**Asian**	**Filipino**
Base model (age and sex adjustment)	1.0	1.35 (1.22–1.50)	1.10 (0.99–1.22)	0.93 (0.80–1.09)	1.30 (1.13–1.51)
Base model + clinical factors[a]	1.0	1.27 (1.14–1.42)	1.15 (1.04–1.28)	1.28 (1.09–1.51)	1.66 (1.43–1.93)
Base model + socioeconomic factors[b]	1.0	1.25 (1.12–1.39)	1.03 (0.91–1.16)	1.08 (0.91–1.28)	1.72 (1.43–2.05)
Base model + behavioral factors[c]	1.0	1.31 (1.18–1.45)	1.18 (1.06–1.31)	0.98 (0.84–1.15)	1.32 (1.15–1.53)
Base model + provider factors[d]	1.0	1.35 (1.21–1.51)	1.09 (0.97–1.21)	0.92 (0.79–1.08)	1.29 (1.11–1.49)
Saturated model with all 34 factors	1.0	1.22 (1.09–1.38)	1.09 (0.95–1.24)	1.35 (1.13–1.61)	1.93 (1.61–2.32)

[a]Clinical factors include systolic blood pressure; low-density lipoprotein level; baseline estimated glomerular filtration rate; glycosylated hemoglobin; body mass index; indicators for hypertension, cardiovascular disease, heart failure, insulin therapy, lipid-lowering and antihypertensive medication use; diabetes duration; antihypertensive medication intensification during follow-up (new medication added after baseline); change in systolic blood pressure; and glycosylated hemoglobin during follow-up (continuous variable).

[b]Socioeconomic factors include education, income, assets, and neighborhood deprivation index. Social factors include limited English proficiency and nativity.

[c]Behavioral factors include smoking and exercise variables, self-monitoring of blood glucose, oral diabetes medication adherence, and antihypertensive medication adherence.

[d]Provider factors include poor provider communication; patient/provider race and gender concordance.