Nephrol Dial Transplant (2011) 26: 899–908
doi: 10.1093/ndt/gfq473
Advance Access publication 5 August 2010

Race differences in access to health care and disparities in incident chronic kidney disease in the US

Kira Evans[1,2], Josef Coresh[1,2], Lori D. Bash[1,2], Tiffany Gary-Webb[4], Anna Köttgen[1,2], Kathryn Carson[1,2] and L. Ebony Boulware[1,2,3]

[1]Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA, [2]Welch Center for Prevention, Epidemiology and Clinical Research, Baltimore, MD, USA, [3]Division of General Internal Medicine, Johns Hopkins School of Medicine, Baltimore, MD, USA and [4]Department of Epidemiology, Columbia University, New York, NY

Correspondence and offprint requests to: Kira Evans; E-mail: kira.e.evans@gmail.com
K.E. and L.E.B. developed the overall scope and outline for this analysis and were the primary contributors to the data analyses, writing and revision of the final manuscript. J.C., L.B., K.C., A.K. and T.G. also made significant contributions to the oversight and revisions of the analyses and final manuscript. The results presented in this paper have not been published previously in whole or part.

Abstract

Background. The contribution of race differences in access to health care to disparities in chronic kidney disease (CKD) incidence in the United States is unknown.
Methods. We examined race differences in usual source of health care, health insurance and CKD incidence among 3883 Whites and 1607 Blacks with hypertension or diabetes enrolled in the Atherosclerosis Risk in Communities Study. In multivariable analyses, we explored the incremental contribution of access to health care in explaining Blacks' excess CKD incidence above and beyond other socioeconomic, lifestyle and clinical factors.
Results. Compared with Whites, Blacks had poorer access to health care (3 *vs* 0.3% with no usual source of health care or health insurance, $P < 0.001$) and experienced greater CKD incidence (14.7 *vs* 12.0 cases per 1000 person-years, $P < 0.001$). Blacks' excess risk of CKD persisted after adjusting for demographic, socioeconomic, lifestyle and clinical factors [hazard ratio (HR) (95% confidence interval (95% CI)) = 1.21 (1.01–1.47)]. Adjustment for these factors explained 64% of the excess risk among Blacks. The increased risk for CKD among Blacks was attenuated after additional adjustment for race differences in access to health care [HR (95% CI) = 1.19 (0.99–1.45)], which explained an additional 10% of the disparity.
Conclusions. In this population at risk for developing CKD, we found that poorer access to health care among Blacks explained some of Blacks' excess risk of CKD, beyond the excess risk explained by demographic, socioeconomic, lifestyle and clinical factors. Improved access to health care for high-risk individuals could narrow disparities in CKD incidence.

Keywords: access to health care; chronic kidney disease; disparities

Introduction

Race disparities in the incidence and progression of chronic kidney disease (CKD) have been significant and persistent in the United States (US), with Blacks experiencing four to six times greater incidence of end-stage renal disease (ESRD) compared with Whites over the past decade [1]. Although clinical, socioeconomic and lifestyle factors have been shown to contribute to Blacks' greater risk of ESRD, these factors have not been shown to fully explain the disparity [2–5]. Furthermore, few studies have assessed factors contributing to race differences in the development of earlier stages of CKD among persons with diabetes or hypertension [6] who are at significantly greater risk of CKD incidence and progression compared with the general population and could benefit most from early clinical intervention.

'Access to health care', defined as 'the timely use of personal health services to achieve the best possible health outcomes' [7], has been associated with superior treatment and control of risk factors for CKD incidence and progression [8–16] and represents a potential mechanism through which the risk of CKD among high-risk individuals could be ameliorated. The presence of both a usual source of care and health insurance are important indicators of individuals' access to health care, with the presence of a usual source of care more powerfully predicting access to health care than insurance status in some studies [17].

The influence of documented race differences in access and utilization of health care [16,18–28] on race disparities in CKD incidence is unclear. Improved understanding of this influence, particularly among persons at greatest risk of progression to ESRD, could help elucidate mechanisms for disparities and enhance efforts to narrow disparities. Using data from the Atherosclerosis Risk in Communities

(ARIC) Study, we explored the potential contribution of race differences in access to health care to race disparities in CKD incidence.

Materials and methods

Study design and population

The ARIC Study is a US population-based prospective cohort designed to investigate the aetiology and variations in patterns of cardiovascular disease. Participants aged 45–64 were recruited using probability sampling from 1987 to 1989 in Forsyth County, NC; Jackson, MS; Washington County, MD; and Minneapolis, MN. Blacks were over-sampled in NC and exclusively sampled in Jackson [29]. Participants returned to the clinic every 3 years for follow-up. Information on usual source of health care was not collected until Visit 2 (1990–1992), defined as the baseline visit in this analysis. Because we sought to identify the relation between access to health care and CKD incidence among participants at greatest risk of progression to ESRD, we limited our analysis to participants with hypertension and/or diabetes at baseline. The protocol was approved by the institutional review board at each participating site and written consent was obtained from all participants.

Among 14 348 ARIC participants present at baseline, 6790 Black and White participants had an estimated glomerular filtration rate (eGFR) >60 mL/min/1.73 m^2 [30] and had either hypertension or diabetes. The presence of hypertension was determined by baseline systolic blood pressure (SBP) ≥ 140 mmHg or diastolic blood pressure (DBP) ≥ 90 mmHg, self-reported physician diagnosis of hypertension or current use of hypertension medications. The presence of diabetes was determined by baseline non-fasting glucose ≥ 200 mg/dL, fasting glucose ≥ 140 mg/dL (consistent with recommendations at the time of baseline data collection), self-reported physician diagnosis of diabetes or use of diabetes medications.

We excluded participants with missing data (n = 487), participants unavailable for follow-up (n = 864) and Black participants from Minneapolis and Washington County (n = 29) due to their limited numbers. Compared with 5490 included participants, excluded participants were more likely to be female (59 *vs* 54%), Black (50 *vs* 30%), have annual household incomes of <$16 000 (34 *vs* 26%) and smoke (25 *vs* 20%) (all P < 0.001). Excluded participants were less likely to have completed high school (26 *vs* 33%), have health insurance (84 *vs* 90%) or have a usual source of health care (94 *vs* 96%) (all P < 0.001). Excluded participants also had slightly higher baseline eGFR (93 *vs* 90 mL/min/1.73 m^2; P < 0.001).

Sociodemographic, lifestyle and clinical data

Participants' self-reported demographics, smoking status, alcohol consumption and medication use (verified by inspection of medication bottles) were collected at baseline. Body mass index (BMI) was calculated using measured weight (in kilogrammes)/height (in metres)^2. Blood pressure was recorded as the average of the second and third readings using a random-zero sphygmomanometer. Methods used for measuring fasting blood samples [31], serum glucose [32], plasma high-density lipoprotein (HDL) cholesterol [33] and plasma triglycerides [33] are described elsewhere.

Access to health care

Participants were asked 'When you want help with a health problem, where do you usually go?' Answers included 'private physician', 'walk-in clinic', 'HMO', 'regular clinic', 'emergency room' and 'other'. Respondents choosing 'other' specified their source of health care by free response. We considered respondents reporting use of a private physician, HMO, regular clinic, regular pharmacist, regular hospital (not emergency room) or regular nurse to have a usual source of health care. Similarly worded questions assessing participants' self-reported use of health services have been used in several national surveys including the 1977 National Medical Care Expenditure Survey, the 1987 National Medical Expenditure Survey and the 1996 Medical Expenditure Panel Survey [34]. Respondents were also asked 'Do you have health insurance, such as Medicare, or a medical plan, such as an HMO, which pays part of a hospital, doctor's or surgeon's bill?' We created four categorical levels of access to health care (usual source of health care present/health insurance present; usual source of health care present/health insurance absent; usual source of health care absent/health insurance present; usual source of health care absent/health insurance absent).

Incident CKD ascertainment

Participants achieving an eGFR ≤ 60 mL/min/1.73 m^2 at Visit 4 or having a hospitalization or death with CKD during the follow-up period (1990–2004) were classified with incident CKD. Creatinine concentration was measured with a modified kinetic Jaffe reaction [18] and was corrected for inter-laboratory differences (calibrated with Cleveland Clinic measurement standards by subtraction of 0.24 mg/dL from baseline measurements and by addition of 0.18 mg/dL to Visit 4 measurements). To estimate eGFR, we used the CKD-EPI equation: $GFR = 141 \times \min(Scr/\kappa, 1)^{\alpha} \times \max(Scr/\kappa, 1)^{-1.209} \times 0.993^{Age} \times 1.018$ [if female] $\times 1.159$ [if black] where Scr is serum creatinine, κ is 0.7 for females and 0.9 for males, α is −0.329 for females and −0.411 for males, min indicates the minimum of Scr/κ or 1 and max indicates the maximum of Scr/κ or 1 [35].

Participants were telephoned annually to collect information on hospitalizations and deaths, which were validated through death certificates and hospitalization records obtained via ongoing cohort and community surveillance. Hospital and death records with ICD-9 codes for chronic renal disease (581–583 or 585–588), hypertensive renal disease (403), hypertensive heart and renal disease (404), unspecified disorder of kidney and ureter (593.9), diabetes with renal manifestations (250.4), kidney transplant, renal dialysis or adjustment/fitting of catheter (V42.0, V45.1 or V56) or either haemodialysis (39.95) or peritoneal dialysis (54.98) without acute renal failure (584, 586, 788.9 and 958.5) were recorded as events. Primary or contributing causes of death and hospitalizations with any related ICD-9 code listed above were included as cases. Hospitalizations and deaths were not formally adjudicated.

Statistical analysis

We described baseline characteristics and ascertained bivariate associations with access to health care according to Black or White race. We also examined race differences in the self-reported sources of usual health care and explored whether these differences varied according to health insurance status (insured *vs* uninsured). To assess the association between our definitions of access to health care with measures of health care delivery, we examined the independent association of access to care and treatment or control of hypertension and diabetes among participants with these risk factors at baseline using a logistic regression model controlling for demographic, socioeconomic status (SES), lifestyle and clinical factors. We defined treatment of hypertension and diabetes according to participants' self-reported use of hypertension or diabetes medication at baseline. We assessed participants as having hypertension control if their baseline SBP was <140 mmHg and their baseline DBP was <90 mmHg, consistent with clinical standards at the time of participant recruitment [36]. We assessed participants as having diabetes control if their baseline non-fasting glucose was <200 mg/dL or their baseline fasting glucose was <140 mg/dL, also consistent with clinical standards at the time of participant recruitment [37]. We did not use haemoglobin A1c, as it was not available on all participants.

After confirming the assumption of proportional hazards, we performed Cox proportional hazards models to quantify the Black–White disparity in CKD incidence, adjusting for participant sex, age, site of study enrolment, annual household income, years of education, access to health care, smoking, alcohol use, presence of hypertension and diabetes, BMI, eGFR, triglycerides and HDL. BMI and HDL cholesterol were entered as continuous variables. Triglycerides were log transformed due to a skewed distribution. We created a spline term for eGFR (using eGFR ≥ 90 mL/min/1.73 m^2 as a reference group and allowing for a linear increase in the log hazard for eGFR values between 60 and 89 mL/min/1.73 m^2). In sequential multivariable Cox proportional hazard models, we assessed the independent contribution of access to health care in explaining Blacks' excess CKD incidence, after adjusting for all other known risk factors. Model 1 adjusted for age, sex, baseline eGFR and study site. Model 2 included the variables in Model 1 and socioeconomic factors, lifestyle factors and clinical factors. Model 3 included the categorical variable for access to health care (usual source of health care present/health insurance present; usual source of health care present/health insurance absent;

usual source of health care absent/health insurance present; usual source of health care absent/health insurance absent) in addition to the aforementioned risk factors. We quantified the attenuation of the hazard ratio as the percent excess CKD incidence in Blacks explained by the addition of access to health care to the model using the equation $(HR_{Model\ 1} - HR_{Model\ n})/(HR_{Model\ 1} - 1.0)$.

Results

Baseline characteristics and access to health care

Among 3883 (71%) White and 1607 (29%) Black participants with either hypertension or diabetes, most (93%) participants had hypertension, 22% had diabetes and 88% reported having a usual source of health care and health insurance. Compared with Whites, Blacks were younger, more likely to be female, had less education and had lower annual household incomes. Blacks were more likely than Whites to smoke, have diabetes and have greater BMI, but were less likely than Whites to consume alcohol, had greater mean eGFR values, lower triglycerides and higher HDL cholesterol levels. Although most participants reported having either a usual source of care or health insurance, Blacks were more likely than Whites to report having neither a usual source of health care nor insurance (Table 1).

Among all participants, greater access to health care (presence of a usual source of health care and/or health insurance) was associated with female sex, greater education, greater household income and non-smoking status. Current consumption of alcohol was associated with greater access to health care among Whites but poorer access to health care among Blacks. Among Blacks, eGFR was lowest among participants with a usual source of care and health insurance. Among both Blacks and Whites, triglycerides were lowest among participants without a usual source of care or health insurance, but among Blacks, HDL levels were lowest among participants with a usual source of care and health insurance. Whites with diabetes were more likely than Whites without diabetes to have a usual source of health care and insurance, but this trend was not evident among Blacks. The presence of a usual source of health care and insurance varied by geographic study site (Table 2).

Table 1. Comparing baseline characteristics of Whites and Blacks with hypertension and/or diabetes and intact kidney function

Baseline characteristics	All (*N* = 5490)	Whites (*N* = 3883), *n* (%)	Blacks (*N* = 1607), *n* (%)	P-value
Age (years), mean (SD)	57.9 (5.7)	58.3 (5.6)	56.8 (5.8)	<0.001
Sex				<0.001
Male	2515 (46)	1960 (50)	555 (35)	
Female	2975 (54)	1923 (50)	1052 (65)	
Socioeconomics				
Education (years)				<0.001
<11	1409 (26)	728 (19)	681 (42)	
12–16	2280 (41)	1818 (47)	462 (29)	
17–21	1801 (33)	1337 (34)	464 (29)	
Annual household income				<0.001
Under $16000 ($25382)[a]	1424 (26)	529 (14)	895 (56)	
$16000–34999 ($25382–55523)	1924 (35)	1450 (37)	474 (30)	
$35000–50000 ($55523–79320)	1031 (19)	892 (23)	139 (9)	
$50000+ ($79320+)	1111 (20)	1012 (26)	99 (6)	
Lifestyle factors				
Current smoker	1120 (20)	723 (19)	397 (25)	<0.001
Current drinker	2907 (53)	2373 (61)	534 (33)	<0.001
Clinical factors				
eGFR mL/min/1.73 m^2, mean (SD)	90 (14)	87 (12)	96 (17)	<0.001
Triglycerides, median (IQR[b])	126 (89–181)	135 (97–195)	105 (77–145)	<0.001
HDL, mean (SD)	48 (16)	46 (16)	52 (17)	<0.001
BMI, mean (SD)	29 (6)	29 (5)	31 (6)	<0.001
Hypertension[c]	5131 (93)	3625 (93)	1506 (94)	0.481
Diabetes[d]	1233 (22)	773 (20)	460 (29)	<0.001
Access to health care factors				<0.001
USOC present/insurance present	4815 (88)	3650 (94)	1165 (73)	
USOC present/insurance absent	460 (8)	128 (3)	332 (21)	
USOC absent/insurance present	158 (3)	94 (3)	64 (4)	
USOC absent/insurance absent	57 (1)	11 (0.3)	46 (3)	
Centre				
Forsyth County, NC	1207 (22)	1028 (26)		179 (11)
Jackson, MS	1428 (26)	0		1428 (89)
Minneapolis, MN	1292 (24)	1292 (33)		0
Washington County, MD	1563 (28)	1563 (40)		0

USOC, usual source of care.
[a]Translated into 2007 dollar amount.
[b]25th–75th centiles.
[c]Hypertension was defined as SBP ≥ 140 mmHg, DBP ≥ 90 mmHg, self-report or current use of hypertension medications.
[d]Diabetes was defined as non-fasting glucose ≥ 200 mg/dL or fasting glucose ≥ 140, self-report or current use of diabetes medications.

Table 2. Baseline characteristics among Blacks and Whites with hypertension and/or diabetes: according to presence of a usual source of care and health insurance, stratified by race

	Whites (n = 3883)					Blacks (n = 1607)				
	Usual source of care and insurance status, n (%)					Usual source of care and insurance status, n (%)				
Baseline socio-demographics	USOC present/insurance present (n = 3650)	USOC present/insurance absent (n = 128)	USOC absent/insurance present (n = 94)	USOC absent/insurance absent (n = 11)	P-value	USOC present/insurance present (n = 1165)	USOC present/insurance absent (n = 332)	USOC absent/insurance present (n = 64)	USOC absent/insurance absent (n = 46)	P-value
Age					0.005					0.031
<50	257 (91)	12 (4)	12 (4)	1 (0.4)		132 (70)	40 (21)	10 (5)	6 (3)	
50–54	779 (93)	33 (4)	24 (3)	2 (0.2)		304 (70)	96 (22)	24 (6)	11 (3)	
55–59	948 (95)	28 (3)	20 (2)	4 (0.4)		315 (72)	91 (21)	11 (3)	18 (4)	
60–65	1064 (93)	50 (4)	22 (2)	4 (0.4)		250 (71)	79 (23)	12 (3)	10 (3)	
65+	602 (97)	5 (1)	16 (3)	0 (0.0)		164 (83)	26 (13)	7 (4)	1 (1)	
Sex					0.012					<0.001
Male	1841 (94)	53 (3)	60 (3)	6 (0.3)		398(72)	100 (18)	33 (6)	24 (4)	
Female	1809 (94)	75 (4)	34 (2)	5 (0.3)		767 (73)	232 (22)	31 (3)	22 (2)	
Socioeconomics										
Education (years)					<0.001					<0.001
<11	636 (87)	66 (9)	24 (3)	2 (0.3)		436 (64)	189 (28)	29 (4)	27 (4)	
12–16	1736 (95)	37 (2)	38 (2)	7 (0.4)		330 (71)	91 (20)	27 (6)	14 (3)	
17–21	1278 (96)	25 (2)	32 (2)	2 (0.2)		399 (86)	52 (11)	8 (2)	5 (1)	
Income					<0.001					<0.001
Under \$16000 (\$25382)[a]	438 (83)	70 (13)	15 (3)	6 (1)		557 (62)	253 (28)	45 (5)	40 (5)	
\$16000–34999 (\$24382–55523)	1368 (94)	43 (3)	34 (2)	5 (0.3)		383 (81)	72 (15)	14 (3)	5 (1)	
\$35000–50000 (\$55523–79320)	861 (97)	7 (1)	24 (3)	0		130 (94)	4 (3)	4 (3)	1 (1)	
\$50000+ (\$79320+)	983 (97)	8 (1)	21 (2)	0		95 (96)	3 (3)	1 (1)	0	
Lifestyle factors										
Smoker	656 (91)	32 (4)	29 (4)	6 (1)	<0.001	256 (64)	90 (23)	26 (7)	25 (6)	<0.001
Drinker	2254 (95)	48 (2)	63 (3)	8 (0.3)	<0.001	372 (70)	108 (20)	32 (6)	22 (4)	0.004
Clinical factors mean (SD)										
eGFR	87 (12)	89 (13)	90 (11)	87 (14)	<0.001	95 (17)	98 (17)	102 (16)	105 (18)	<0.001
Triglycerides, median (IQR[b])	135 (97–195)	146 (109–217)	130 (84–188)	106 (52–183)	<0.001	105 (78–142)	107 (77–151)	113 (72–140)	91 (72–149)	0.031

Continued

Table 2. *Continued*

Baseline socio-demographics	Whites (n = 3883)					Blacks (n = 1607)				
	Usual source of care and insurance status, n (%)					Usual source of care and insurance status, n (%)				
	USOC present/insurance present (n = 3650)	USOC present/insurance absent (n = 128)	USOC absent/insurance present (n = 94)	USOC absent/insurance absent (n = 11)	P-value	USOC present/insurance present (n = 1165)	USOC present/insurance absent (n = 332)	USOC absent/insurance present (n = 64)	USOC absent/insurance absent (n = 46)	P-value
HDL	46 (16)	43 (16)	47 (15)	45 (12)	0.779	52 (16)	52 (16)	55 (25)	57 (26)	<0.001
BMI	29 (5)	30 (6)	28 (5)	29 (6)	0.053	31 (6)	31 (7)	30 (6)	31 (9)	<0.001
Hypertension[c]	3411 (94)	116 (3)	88 (2)	10 (0.3)	0.635	1098 (73)	307 (20)	57 (4)	44 (3)	0.253
Diabetes[d]	714 (92)	40 (5)	16 (2)	3 (0.4)	0.009	323 (70)	107 (23)	18 (4)	12 (3)	0.436
Centre					<0.001					<0.001
Forsyth County, NC	958 (93)	20 (2)	45 (4)	5 (1)		150 (84)	15 (8)	9 (5)	5 (3)	
Jackson, MS	0	0	0	0		1015 (71)	317 (22)	55 (4)	41 (3)	
Minneapolis, MN	1250 (97)	22 (2)	18 (1)	2 (0.2)		0	0	0	0	
Washington County, MD	1442 (92)	86 (6)	31 (2)	4 (0.3)		0	0	0	0	

Smoker, current smoker; Drinker, current drinker; USOC, usual source of care (USOC present includes use of a private physician, HMO, regular clinic, regular pharmacist, regular hospital or regular nurse).
[a]Translated into 2007 dollar amount.
[b]25th–75th percentiles.
[c]Hypertension was defined as blood pressure ≥ 140/90 mmHg, self-report or current use of hypertension medicines.
[d]Diabetes defined as non-fasting glucose ≥ 200 mg/dL or fasting ≥ 140, self-report or current use of diabetes medicines.

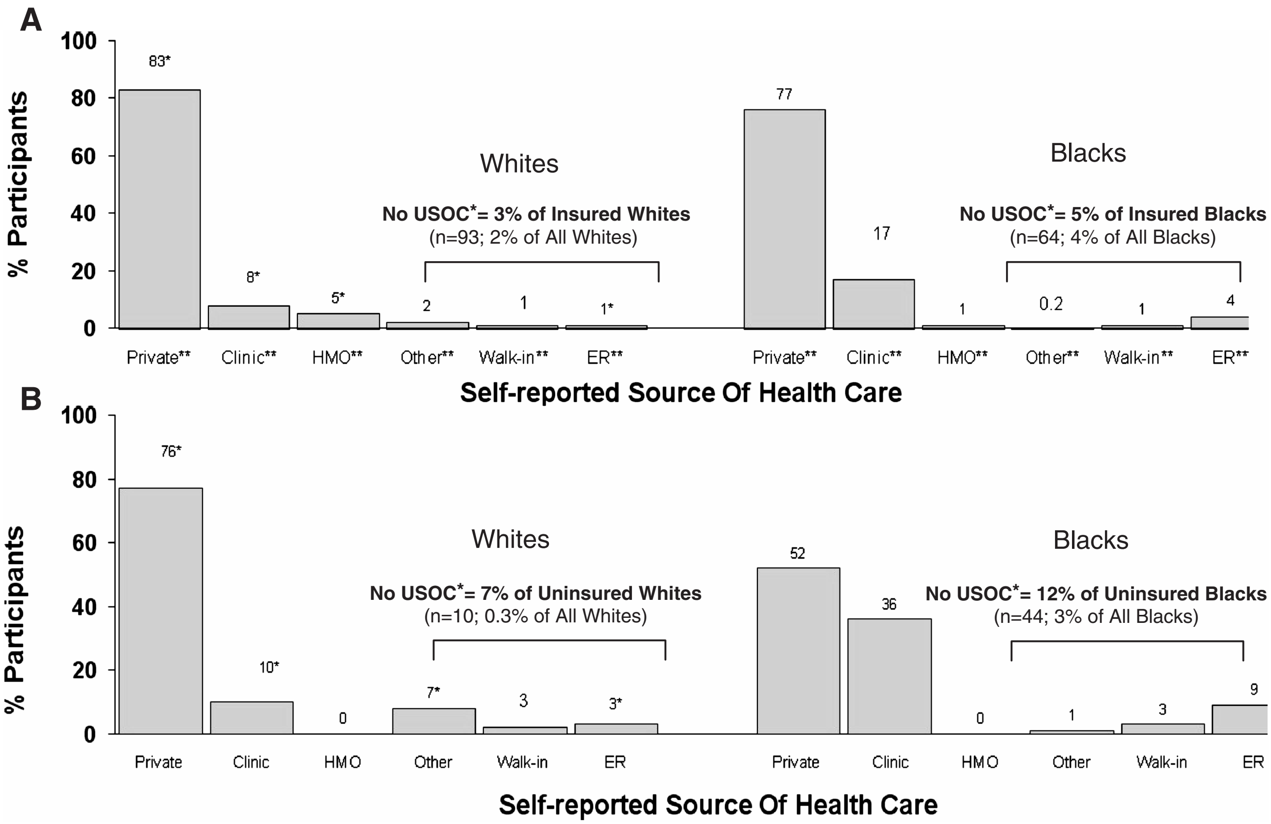

Fig. 1. Self reported source of health care for (A) insured and (B) uninsured Blacks and Whites (*USOC = usual source of care—Blacks and Whites statistically significantly **different**, P < 0.05; Private = private physician; Clinic = regular clinic; HMO = health maintenance organization; Walk-in = walk-in clinic; ER = emergency room; Other = includes use of family members/friends, pharmacist, nurse, hospital, or no care).

Table 3. Factors explaining the excess risk of incident CKD in Blacks compared with Whites with hypertension and/or diabetes

Variables adjusted for in model	HRR*	95% CI	P-value (for HRR)	% excess risk explained[a]
Model 1: age, sex, eGFR, study site	1.59	1.34–1.88	<0.001	
Model 2: Model 1 + SES + lifestyle + clinical factors	1.21	1.01–1.47	0.045	64
Model 3: Model 1 + SES + lifestyle + clinical factors + access to health care	1.19	0.99–1.45	0.063	10

Incident CKD = eGFR ≤ 60 mL/min/1.73 m^2 and or hospitalization or death with CKD. *HRR = Hazard Rate Ratios representing the relative hazards for developing incident CKD in Blacks compared with Whites. Access to health care = USOC present/insurance present, USOC present/insurance absent, USOC absent/insurance present, USOC absent/insurance absent; SES = annual household income, years of education; Lifestyle Factors = current smoking, current alcohol use; Clinical Factors = presence/absence of hypertension, presence/absence of diabetes, BMI, levels of triglycerides and HDL cholesterol.

[a] % excess risk explained = $(HR_1 - HR_2)/(HR_1 - 1.0)$ where HR_1 is the HR adjusted for age, sex, and baseline eGFR and HR_2 is the HR adjusted for age, sex, and baseline eGFR plus the additional set of risk factors.

Figure 1 shows participants' self-reported sources of health care according to their health insurance status. Among insured participants, Whites were more likely than Blacks to use a private physician (86 *vs* 77%) and HMO (5 *vs* 1%) for their usual source of health care (both P < 0.001). Conversely, insured Blacks were more likely than their White counterparts to go to a regular health clinic (17 *vs* 8%) or the emergency department (4 *vs* 1%) for their usual source of health care (both P < 0.001). Similar trends in reported sources of health care persisted among participants lacking health insurance. Uninsured Whites were more likely than uninsured Blacks to use a private physician (76 *vs* 52%); however, uninsured Blacks were three times more likely to use regular health clinics (36 *vs* 10%) or the emergency department (9 *vs* 3%) for their usual source of health care (all P < 0.001). There were no statistically significant race differences in reported use of walk-in clinics among insured or uninsured participants (1 and 3% of Whites and Blacks, respectively). Among participants reporting 'other' sources of health care, Whites were more likely than Blacks to receive their health care from family members or friends, but were equally as likely to use hospitals or other medical professionals such as nurses or pharmacists. Overall, only 6% of Whites (*vs* 28% of Blacks) lacked either a usual source of health care or insurance.

A multivariable model examining the independent relation of access to care and treatment or control of CKD risk factors among participants at baseline demonstrated a significantly decreased likelihood of treatment or control of hypertension and diabetes among persons with poorer access to care, even after controlling for other demographic, SES, lifestyle and clinical factors. When compared with participants reporting they had both a usual source of care and health insurance, participants with a usual source of care but no health insurance, with no usual source of care but with health insurance and with neither a usual source of care nor health insurance all had less odds of hypertension treatment and control [adjusted odds ratios (OR) 95% confidence intervals (95% CI) = 0.64 (0.49–0.84), 0.31 (0.22–0.44) and 0.33 (0.18–0.59), respectively, all $P < 0.05$]. Similarly, when compared with participants reporting they had both a usual source of care and health insurance, participants with a usual source of care but no health insurance, with no usual source of care but with health insurance and with neither a usual source of care nor health insurance all had less odds of diabetes treatment and control [adjusted OR (95% CI) = 0.82 (0.55–1.21), 0.42 (0.21–0.85) and 0.31 (0.11–0.89), respectively, all $P < 0.05$].

Incremental contribution of access to health care to race disparities in CKD incidence

A total of 799 incident CKD events occurred during a mean follow-up of 11.4 years (12.0 and 14.7 events per 1000 person-years among Whites and Blacks, respectively). Events were comprised of participants achieving follow-up eGFR < 60 mL/min/1.73 m^2 (*n* = 351, 29%), CKD hospitalization or death (*n* = 564, 56%) and both endpoints (*n* = 116, 15%). Blacks experienced a 59% excess CKD incidence compared with Whites, after adjusting for age, sex, study centre and baseline eGFR [HR (95% CI) = 1.59 (1.34–1.88)]. Additional adjustment for SES, lifestyle and clinical factors explained 64% of the disparity, although the excess risk among Blacks remained statistically significant [HR (95% CI) = 1.21 (1.01–1.47)]. Further adjustment for race differences in access to health care explained an additional 10% of Blacks' excess CKD risk and attenuated the differences between Blacks and Whites of the disparity [HR (95% CI) = 1.19 (0.99–1.45)] (Table 3).

Discussion

In this US prospective study of persons with hypertension or diabetes and eGFR >60 mL/min/1.73 m^2 at baseline, Blacks and Whites at risk of CKD incidence experienced differences in both the presence and quality of their health care, with Blacks more likely to lack both health insurance and a usual source of care and Blacks utilizing different usual sources of health care compared with Whites. Blacks had nearly 60% excess risk of CKD incidence compared with Whites after adjustment for age, sex, study centre and baseline eGFR. Adjustment for socioeconomic, lifestyle and clinical factors explained 64% of the race disparity in CKD incidence, but the disparity was not completely attenuated until models were additionally adjusted for race differences in access to health care. These findings suggest that whilst socioeconomic, lifestyle and clinical factors explain the greatest proportion of the disparity, access to health care may also play a role in ethnic/race disparities in CKD incidence among persons at high risk for CKD incidence and progression.

Our findings are among the first to provide prospective evidence of the role of access to health care in explaining racial disparities in incident CKD above and beyond socioeconomic, lifestyle and clinical factors and have implications for future efforts to narrow disparities in patients with CKD risk factors. Whilst several studies have explored possible explanations for Black–White disparities in the development of ESRD [2–5,38,39], few have explored potential explanations for race disparities in the incidence of earlier stages of CKD. A previous study found that access to health care explained some of the disparity in less advanced CKD, but this study limited the definition of access to health care as only the presence or absence of health insurance [6]. Our study incorporated a broader definition of access to care, which is supported by research demonstrating that the presence of a usual source of care is associated with improved continuity, comprehensiveness and timely receipt of health care [17,40].

Greater access to health care has been associated with improved treatment and control of hypertension and diabetes, a potential mechanism through which better access to health care could prevent the incidence of CKD. Previous research has demonstrated that differences in types of insurance (Medicaid *vs* Medicare *vs* private insurance) and in the source of health care (e.g. private physicians' office or emergency rooms) may lead to differences in clinical services rendered [41–46] as well as health outcomes [47–49]. Moy *et al*. showed that, among persons with hypertension, those without a usual source of health care or health insurance were less likely to receive 'screening, follow-up care or pharmacologic treatment for hypertension' [10]. Studies in individuals with diabetes have demonstrated similar relationships between access to health care and improved glycemic monitoring and control [11,13–15, 50–52]. Our own analyses, demonstrating a strong association between our measure of access to health care with treatment and control of hypertension and diabetes at baseline, support this hypothesis.

Both race differences in the presence of access to health care as well as race differences in the quality of access may have contributed to our findings of race disparities in CKD incidence. We found Blacks were less likely than Whites to have health insurance or a usual source of health care and that the distribution of types of usual care differed between Blacks and Whites. Whilst the total proportion of Blacks and Whites with no usual source of health care was small, differences in the distribution of the type of usual source of health care reported by Blacks and Whites were significant. Therefore, it is possible that differences in quality of care were more influential than the absence of usual care itself on disparities in CKD incidence. For example, Blacks were less likely than Whites to report seeing a private physician and more likely to use HMOs, even among those with a usual source of health care. These results are consistent with studies of access to health care in other clinical areas [16,18–28]. We also found that Blacks were less likely than Whites to have health insurance, although data on types of health insurance were not collected in the ARIC Study, precluding a more in-depth review of the effects of differences in insurance type (e.g. public *vs* private). Further studies are needed to determine what types of differences in health insurance (e.g. prescription medication coverage, co-pays) or usual source of care (e.g. continuous relationships with a single primary care provider *vs* more episodic care, characteristic of health clinics) most strongly impact the clinical outcomes of patients at risk of CKD incidence.

Limitations of this study deserve mention. First, it is possible that ARIC participants at high risk of CKD incidence were not representative of persons at high risk of CKD in the US general population. Access to health care among ARIC participants differed from recent population estimates (7 and 3% of Black and White ARIC participants with no usual source of health care *vs* 14 and 13% of Blacks and Whites in the US general population in 2007; 23 and 4% of Blacks and Whites with no health insurance in ARIC *vs* 17 and 11% of Blacks and Whites in the US general population in 2007) [53,54]. These differences may reflect temporal changes in health care occurring after ARIC baseline data was collected and may limit the generalizability of our findings. Further research will be needed to assess the impact of recent changes in US health insurance policy on race disparities in CKD incidence [55].

Second, Blacks were recruited exclusively from Jackson, MS, a rural, southern district where access to health care may be less adequate than other more urban regions. Although we attempted to adjust for differences in participants enrolled at different ARIC Study sites using standard statistical methods, it is possible that we could not completely eliminate confounding effects of geographic differences in access to care, quality of care or other social determinants of health. Such unmeasured and uncontrolled confounding has the potential to overestimate the race disparities in CKD and could explain the higher rates of poor access to care among Blacks in this study compared with national averages. It is also possible that participant's level of access to health care may have changed during follow-up, possibly introducing misclassification bias. Third, we considered participants reporting using pharmacists, regular health clinics and family members in the health care field as having a usual source of health care, but the content of this care is unclear. Fourth, the ARIC Study did not collect data on urine protein at baseline; some participants with kidney damage and normal eGFR could have been misclassified as not having CKD. Furthermore, incident CKD defined by eGFR was detectable only at Visit 4, resulting in stepped data and possibly an underestimate of CKD incidence if cases were more likely to drop out of the study or die before their follow-up visit. Also, CKD hospitalizations and deaths may represent more advanced cases of CKD compared with cases defined by eGFR $\leq$ 60 mL/min/1.73 m^2 and variations in physicians' subjective judgments regarding coding practice could introduce misclassification bias. However, this composite outcome has been used in several prior studies [39,56–58] and results of an analysis incorporating more limited definitions of CKD incidence were consistent with our main findings. Notwithstanding these limitations, our study provides important evidence regarding influence of access to health care in explaining Blacks' excess CKD incidence.

Conclusion

In summary, the presence and quality of access to health care was different for Blacks and Whites at risk of CKD incidence. Poorer access to health care among Blacks compared with Whites explained some of Blacks' excess CKD incidence, above and beyond the excess risk explained by socioeconomic, lifestyle and clinical factors. Improved access to health care for high-risk individuals could narrow disparities in CKD incidence.

Acknowledgements. The ARIC Study is a collaborative study supported by contracts N01-HC-55015, N01-HC-55016, N01-HC-55018, N01-HC-55019, N01-HC-55020, N01-HC-55021 and N01-HC-55022 from the National Heart, Lung, and Blood Institute (to J.C.). This work was also funded by the National Heart, Lung and Blood Institutes (N01-HC-55020 S1, to K.E.) and the National Institute of Diabetes and Digestive and Kidney Diseases (K23DK070757, to L.E.B.).

Conflict of interest statement. None declared.

References

1. US Renal Data System. USRDS 2007 Annual Data Report Atlas of Chronic Kidney Disease and End-Stage Renal Disease in the United States. 2007
2. Cowie CC, Port FK, Wolfe RA *et al*. Disparities in incidence of diabetic end-stage renal disease according to race and type of diabetes. *N Engl J Med* 1989; 321: 1074–1079
3. Brancati FL, Whittle JC, Whelton PK *et al*. The excess incidence of diabetic end-stage renal disease among blacks. A population-based study of potential explanatory factors. *JAMA* 1992; 268: 3079–3084
4. Li S, McAlpine DD, Liu J *et al*. Differences between blacks and whites in the incidence of end-stage renal disease and associated risk factors. *Adv Ren Replace Ther* 2004; 11: 5–13
5. Perneger TV, Whelton PK, Klag MJ. Race and end-stage renal disease. Socioeconomic status and access to health care as mediating factors. *Arch Intern Med* 1995; 155: 1201–1208
6. Krop JS, Coresh J, Chambless LE *et al*. A community-based study of explanatory factors for the excess risk for early renal function decline in blacks vs whites with diabetes: the Atherosclerosis Risk in Communities study. *Arch Intern Med* 1999; 159: 1777–1783
7. Institute of Medicine. Access to Health Care in America. Washington, DC: National Academy Press, 1993
8. Duru OK, Vargas RB, Kermah D *et al*. Health insurance status and hypertension monitoring and control in the United States. *Am J Hypertens* 2007; 20: 348–353
9. Gandelman G, Aronow WS, Varma R. Prevalence of adequate blood pressure control in self-pay or Medicare patients versus Medicaid or private insurance patients with systemic hypertension followed in a university cardiology or general medicine clinic. *Am J Cardiol* 2004; 94: 815–816
10. Moy E, Bartman BA, Weir MR. Access to hypertensive care. Effects of income, insurance, and source of care. *Arch Intern Med* 1995; 155: 1497–1502

11. Benoit SR, Fleming R, Philis-Tsimikas A *et al*. Predictors of glycemic control among patients with type 2 diabetes: a longitudinal study. *BMC Public Health* 2005; 5: 36
12. Bowker SL, Mitchell CG, Majumdar SR *et al*. Lack of insurance coverage for testing supplies is associated with poorer glycemic control in patients with type 2 diabetes. *CMAJ* 2004; 171: 39–43
13. O'Connor PJ, Desai J, Rush WA *et al*. Is having a regular provider of diabetes care related to intensity of care and glycemic control? *J Fam Pract* 1998; 47: 290–297
14. Parchman ML, Pugh JA, Noel PH *et al*. Continuity of care, self-management behaviors, and glucose control in patients with type 2 diabetes. *Med Care* 2002; 40: 137–144
15. Rhee MK, Cook CB, Dunbar VG *et al*. Limited health care access impairs glycemic control in low income urban African Americans with type 2 diabetes. *J Health Care Poor Underserved* 2005; 16: 734–746
16. Corbie-Smith G, Flagg EW, Doyle JP *et al*. Influence of usual source of care on differences by race/ethnicity in receipt of preventive services. *J Gen Intern Med* 2002; 17: 458–464
17. Sox CM, Swartz K, Burstin HR *et al*. Insurance or a regular physician: which is the most powerful predictor of health care? *Am J Public Health* 1998; 88: 364–370
18. Hargraves JL. The insurance gap and minority health care, 1997–2001. *Track Rep* 2002; 1–4
19. Wherry L, Finegold K. Changes in health insurance coverage and health status by race and ethnicity, 1997–2002. *J Natl Med Assoc* 2004; 96: 1577–1582
20. Weinick RM, Krauss NA. Racial/ethnic differences in children's access to care. *Am J Public Health* 2000; 90: 1771–1774
21. Shone LP, Dick AW, Klein JD *et al*. Reduction in racial and ethnic disparities after enrollment in the State Children's Health Insurance Program. *Pediatrics* 2005; 115: e697–e705
22. Pol LG, Mueller KJ, Adidam PT. Racial and ethnic differences in health insurance for the near elderly. *J Health Care Poor Underserved* 2002; 13: 229–240
23. Park J, Buechner JS. Race, ethnicity, and access to health care, Rhode Island, 1990. *J Health Soc Policy* 1997; 9: 1–14
24. Newacheck PW, Hughes DC, Stoddard JJ. Children's access to primary care: differences by race, income, and insurance status. *Pediatrics* 1996; 97: 26–32
25. Doescher MP, Saver BG, Fiscella K *et al*. Racial/ethnic inequities in continuity and site of care: location, location, location. *Health Serv Res* 2001; 36: 78–89
26. Gaskin DJ, Arbelaez JJ, Brown JR *et al*. Examining racial and ethnic disparities in site of usual source of care. *J Natl Med Assoc* 2007; 99: 22–30
27. Hargraves JL, Hadley J. The contribution of insurance coverage and community resources to reducing racial/ethnic disparities in access to care. *Health Serv Res* 2003; 38: 809–829
28. Weitzman M, Byrd RS, Auinger P. Black and white middle class children who have private health insurance in the United States. *Pediatrics* 1999; 104: 151–157
29. The Atherosclerosis Risk in Communities (ARIC) Study: design, objectives. The ARIC investigators. *Am J Epidemiol* 1989; 129: 687–702
30. National Kidney Foundation. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. *Am J Kidney Dis* 2002; 39: S1–S266
31. National Heart, Lung and Blood Institute Atherosclerosis Risk in Communities (ARIC) Study: Operations Manual 7: Blood Collection and Processing 1987
32. National Heart, Lung and Blood Institute Atherosclerosis Risk in Communities (ARIC) Study: Operations Manual 10: Clinical Chemistry Determinations 1987
33. National Heart, Lung and Blood Institute Atherosclerosis Risk in Communities (ARIC) Study: Operations Manual 8: Lipid and Lipoprotein Determinations 1987
34. Zuvekas SH, Weinick RM. Changes in access to care, 1977–1996: the role of health insurance. *Health Serv Res* 1999; 34: 271–279
35. Levey AS, Stevens LA, Schmid CH *et al*. A new equation to estimate glomerular filtration rate. *Ann Intern Med* 20095150: 604–612
36. The 1988 report of the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure. *Arch Intern Med* 1988; 148: 1023–1038
37. National Diabetes Data Group. Classification and diagnosis of diabetes mellitus and other categories of glucose intolerance. *Diabetes* 1979; 28: 1039–1057
38. Hsu CC, Bray MS, Kao WH *et al*. Genetic variation of the renin–angiotensin system and chronic kidney disease progression in black individuals in the atherosclerosis risk in communities study. *J Am Soc Nephrol* 2006; 17: 504–512
39. Shoham DA, Vupputuri S, Diez Roux AV *et al*. Kidney disease in life-course socioeconomic context: the Atherosclerosis Risk in Communities (ARIC) Study. *Am J Kidney Dis* 2007; 49: 217–226
40. Starfield B, Shi L. The medical home, access to care, and insurance: a review of evidence. *Pediatrics* 2004; 113: 1493–1498
41. DeLaet DE, Shea S, Carrasquillo O. Receipt of preventive services among privately insured minorities in managed care versus fee-for-service insurance plans. *J Gen Intern Med* 2002; 17: 451–457
42. Guller U, Jain N, Curtis LH *et al*. Insurance status and race represent independent predictors of undergoing laparoscopic surgery for appendicitis: secondary data analysis of 145,546 patients. *J Am Coll Surg* 2004; 199: 567–575
43. Lavernia CJ, Lee D, Sierra RJ *et al*. Race, ethnicity, insurance coverage, and preoperative status of hip and knee surgical patients. *J Arthroplasty* 2004; 19: 978–985
44. Roetzheim RG, Pal N, Tennant C *et al*. Effects of health insurance and race on early detection of cancer. *J Natl Cancer Inst* 1999; 91: 1409–1415
45. Sung JF, Alema-Mensah E, Blumenthal DS. Inner-city African American women who failed to receive cancer screening following a culturally-appropriate intervention: the role of health insurance. *Cancer Detect Prev* 2002; 26: 28–32
46. Xu KT. Usual source of care in preventive service use: a regular doctor versus a regular site. *Health Serv Res* 2002; 37: 1509–1529
47. Haas JS, Lee LB, Kaplan CP *et al*. The association of race, socioeconomic status, and health insurance status with the prevalence of overweight among children and adolescents. *Am J Public Health* 2003; 93: 2105–2110
48. Hakim RB, Benedict MB, Merrick NJ. Quality of care for women undergoing a hysterectomy: effects of insurance and race/ethnicity. *Am J Public Health* 2004; 94: 1399–1405
49. Roetzheim RG, Gonzalez EC, Ferrante JM *et al*. Effects of health insurance and race on breast carcinoma treatments and outcomes. *Cancer* 2000; 89: 2202–2213
50. Harris MI. Racial and ethnic differences in health care access and health outcomes for adults with type 2 diabetes. *Diab Care* 2001; 24: 454–459
51. Mainous AG III, Koopman RJ, Gill JM *et al*. Relationship between continuity of care and diabetes control: evidence from the Third National Health and Nutrition Examination Survey. *Am J Public Health* 2004; 94: 66–70
52. Nelson KM, Chapko MK, Reiber G *et al*. The association between health insurance coverage and diabetes care; data from the 2000 Behavioral Risk Factor Surveillance System. *Health Serv Res* 2005; 40: 361–372
53. Pleis JR, Lucas JW. Summary health statistics for U.S. adults: National Health Interview Survey, 2007. *Vital Health Stat 10* 2009; 1–159
54. Martinez ME. Health Insurance Coverage: Early Release of Estimates from the National Health Interview Survey, January–June 2009. Hyattsville, MD: Division of Health Interview Statistics, National Center for Health Statistics, 2009
55. One Hundred Eleventh Congress of the United States of America. The Patient Protection and Affordable Care Act. 2010

56. Bash LD, Erlinger TP, Coresh J *et al*. Inflammation, hemostasis, and the risk of kidney function decline in the Atherosclerosis Risk in Communities (ARIC) Study. *Am J Kidney Dis* 2009; 53: 596–605
57. Bash LD, Selvin E, Steffes M *et al*. Poor glycemic control in diabetes and the risk of incident chronic kidney disease even in the absence of albuminuria and retinopathy: Atherosclerosis Risk in Communities (ARIC) Study. *Arch Intern Med* 2008; 168: 2440–2447
58. Merkin SS, Coresh J, Roux AV *et al*. Area socioeconomic status and progressive CKD: the Atherosclerosis Risk in Communities (ARIC) Study. *Am J Kidney Dis* 2005; 46: 203–213

Received for publication: 6.4.10; Accepted in revised form: 12.7.10

Nephrol Dial Transplant (2011) 26: 908–913
doi: 10.1093/ndt/gfq475
Advance Access publication 4 August 2010

Cigarette smoking and second-hand smoking exposure in adolescents with chronic kidney disease: a study from the Midwest Pediatric Nephrology Consortium

Abiodun Omoloja[1], Deepa Chand[2], Larry Greenbaum[3], Amy Wilson[4], Veronica Bastian[5], Maria Ferris[6], John Bernert[7], Adrienne Stolfi[1] and Hiren Patel[8]

[1]Wright State University, Dayton OH, USA, [2]Children's Hospital Akron, Akron OH, USA, [3]Emory University and Children's Healthcare of Atlanta, Atlanta GA, USA, [4]JW Riley Hospital for Children, Indianapolis, IN, USA, [5]Michigan Children's Hospital, Detroit MI, USA, [6]University of North Carolina, Chapel Hill NC, USA, [7]Tobacco Exposure Biomarkers Section, Division of Laboratory Sciences, Centers for Disease Control and Prevention, Atlanta, GA, USA and [8]Nationwide Children's Hospital, Columbus OH, USA

Correspondence and offprint requests to: Abiodun Omoloja; E-mail: Nephrology@childrensdayton.org

Abstract

Background. Smoking and second-hand smoking [SHS] cause significant cardiovascular mortality and morbidity. In healthy individuals and adults with chronic kidney disease [CKD], cigarette smoking is associated with albuminuria, increased risk for CKD, increased graft loss and progression of renal insufficiency. In children, SHS has been associated with higher blood pressure variability, blood pressure load, elevated C-reactive protein and decreased cognitive function. Using a survey document and urine cotinine, we sought to investigate prevalence of cigarette use and SHS in adolescents with CKD.

Methods. A cross-sectional study was conducted in which adolescents aged 13 to 18 years with CKD were asked to complete a single anonymous self-administered survey. In addition, a single freshly voided urine sample for cotinine measurement was obtained from eligible subjects.

Results. Of 182 subjects, 60 (34%), 25 (14%) and 93 (52%) were transplant recipients, were dialysis dependent and had a glomerulopathy, respectively. Renal status was lacking in four. Twenty-four per cent (24%) had smoked at some point in their lives, and 13% had smoked within the last 30 days of taking the survey. Fifty-two per cent (52%) of all respondents reported living with an adult who smoked, and 54% reported having friends that smoked. Forty-seven per cent (47%) and 44% of those who had never smoked lived with an adult and had friends that smoked, respectively. There was a discrepancy rate of 7% between self-reported non-smokers and urine cotinine, suggesting smoking rates were higher. The highest cotinine/creatinine levels among the non-smokers were observed in those who lived with a smoker and had friends that smoked.

Conclusion. Among adolescents with CKD, cigarette smoking and SHS exposure are prevalent and may be important variables to consider when evaluating renal and cardiovascular risk factors and outcomes in children with CKD.

Keywords: adolescents; cigarettes; CKD; second-hand smoking

Introduction

Tobacco use is the leading preventable cause of cardiovascular morbidity and mortality worldwide, and at least 35 000 deaths occur annually in the USA due to second-hand smoking (SHS), which increases the risk of cardiovascular disease [CVD] by as much as 30% [1]. Although the