Characteristics of Uninsured Americans with Chronic Kidney Disease

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BACKGROUND: In the United States, public health insurance is available for nearly all persons with end-stage renal disease (ESRD). Little is known about the extent of health insurance coverage for persons with non-dialysis dependent chronic kidney disease (CKD).

OBJECTIVE: To describe patterns of health insurance coverage for adults with non-dialysis dependent CKD and to examine risk factors for progression of CKD to ESRD and management of hypertension among those lacking insurance.

DESIGN AND PARTICIPANTS: Cross-sectional analysis of data from a nationally representative sample of 16,148 US adults aged 20 years or older who participated in the National Health and Nutrition Examination Survey 1999-2006.

MEASUREMENTS: National prevalence estimates of health insurance coverage, ESRD risk factors, and treatment of hypertension.

MAIN RESULTS: An estimated 10.0% (95% CI, 8.3%-12.0%) of US adults with non-dialysis dependent CKD were uninsured, 60.9% (95% CI, 58.2%-63.7%) had private insurance and 28.7% (95% CI, 26.4%-31.1%) had public insurance alone. Uninsured persons with non-dialysis dependent CKD were more likely to be under the age of 50 (62.8% vs. 23.0%, $P < 0.001$) and nonwhite (58.7%, vs. 21.8%, $P < 0.001$) compared with their insured counterparts. Approximately two-thirds of uninsured adults with non-dialysis dependent CKD had at least one modifiable risk factor for CKD progression, including 57% with hypertension, 40% who were obese, 22% with diabetes, and 13% with overt albuminuria. In adjusted analyses, uninsured persons with non-dialysis dependent CKD were less likely to be treated for their hypertension (OR, 0.59; 95% CI, 0.40-0.85) and less likely to be receiving recommended therapy with angiotensin inhibitors (OR, 0.45; 95% CI, 0.26-0.77) compared with those with insurance coverage.

CONCLUSIONS: Uninsured persons with non-dialysis dependent CKD are at higher risk for progression to ESRD than their insured counterparts but are less likely to receive recommended interventions to slow disease progression. Lack of public health insurance for patients with non-dialysis dependent CKD may result in missed opportunities to slow disease progression and thereby reduce the public burden of ESRD.

KEY WORDS: chronic kidney disease; uninsured; risk factors; end-stage renal disease; race-ethnicity.
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INTRODUCTION

Nearly 47 million Americans (16% of the population) now lack health insurance coverage.[1] Contrary to recent assumptions about the youthfulness and presumed health of the uninsured,[2] a recent study estimated that 11.4 million, or nearly one-third of working-age Americans without health insurance had at least one chronic condition, including cardiovascular disease, diabetes and hypertension.[3]

End-stage renal disease (ESRD), defined as the requirement for maintenance dialysis or kidney transplantation, now affects over 500,000 Americans, disproportionately affects racial-ethnic minority groups, and costs society in excess of 30 billion dollars annually.[4] Unlike many chronic conditions, public health insurance is available for most Americans with ESRD under the Medicare ESRD program. While fewer than 1% of Medicare enrollees have ESRD, the care of these persons accounts for nearly 7% of the entire Medicare budget.[4] In many instances, ESRD can be a preventable disease. Interventions such as blood pressure lowering and use of angiotensin converting enzyme inhibitors (ACEI) or angiotensin II receptor antagonists (ARB) are effective in slowing progression of CKD if initiated at earlier stages in the disease process.[5–9] However, the Medicare ESRD program only covers persons whose chronic kidney disease (CKD) has already advanced to the point where they require maintenance dialysis. To date, relatively little is known about health insurance coverage for the much larger population with non-dialysis dependent CKD.

Our goals were to describe the patterns of health insurance coverage among a nationally representative sample of US adults with non-dialysis dependent CKD and to compare the prevalence and management of risk

factors for CKD progression among Americans with and without health insurance.

METHODS

Data Sources

We downloaded de-identified public use data from the National Health and Nutrition Examination Survey (NHANES) 1999-2006, a nationally representative survey of the health status of persons residing in the US available at http://www.cdc.gov/nchs/nhanes.htm. NHANES is a continuous, cross-sectional, multistage, stratified, clustered probability sample of the US civilian non-institutionalized population conducted by the National Center for Health Statistics, a branch of the Centers for Disease Control and Prevention. The purpose of NHANES is to determine the prevalence of major diseases and potential risk factors for diseases in the general US population. NHANES conducts both interviews and physical examinations. The interview includes demographic, socioeconomic, dietary, and health-related questions. The examination is conducted at a mobile evaluation clinic or the participant's home and consists of medical, dental, and physiological measurements, as well as laboratory tests administered by highly trained medical personnel.[10]

Study Sample

We identified all participants who completed an NHANES interview between January 1, 1999 and December 31, 2006 (n=41,474). We limited the study population to persons who were aged 20 years or older with urine albumin, urine creatinine, and serum creatinine measurements (n=17,433). Because of the design of NHANES, missing laboratory data are considered to be missing at random.[11] We further excluded persons who were pregnant or menstruating (n=1100) at the time of the examination, those who had an estimated glomerular filtration rate (eGFR) <15 ml/min/1.73 m^2 (n=23) and those who reported receiving dialysis within the prior year (n=19). We also excluded persons who did not know or refused to provide their insurance status (n=22), and those in whom insurance status was missing (n=121). The analytic sample consisted of the remaining 16,148 persons (Fig. 1).

Measures of Kidney Function and Chronic Kidney Disease

We used the re-expressed Modification of Diet in Renal Disease equation to estimate glomerular filtration rate (eGFR) based on serum creatinine, age, race and sex.[12] Serum creatinine values for years 1999-2000 and 2005-2006 were calibrated as recommended by the NHANES analytic guidelines.[11] We included adults with non-dialysis dependent CKD (stages 1–4) defined according to the classification system established by the National Kidney Foundation Kidney Disease Outcomes Quality Initiative.[13] Specifically, the study included participants with mild CKD (stages 1–2) defined as a urinary albumin-to-creatinine ratio (ACR)≥30 mg/g with an eGFR>60 ml/min/1.73 m^2, those with moderate CKD (stage 3) defined as an eGFR of 30 to 59 ml/min/1.73 m^2, and those with severe CKD (stage 4) defined as an eGFR of 15 to 29 ml/min/1.73 m^2.[13]

Assessment of Health Insurance Status

Information on health insurance status was based on self-report during the interview portion of the survey. We ascertained insurance status using answers to the questions: "Are you/is your spouse covered by health insurance or some other kind of health care plan?" and "What kind of health insurance or health care coverage do you/does your spouse have?" We defined uninsured adults as those who reported having no health care coverage at the time of the interview.[14] Because the type of health coverage might also influence an individual's access to medical care and risk factor management, we further categorized health insurance coverage into public and private sources. We defined publicly insured participants as those who reported having Medicare, Medicaid, and/or other government-sponsored insurance. We defined privately insured participants as those who were insured by a non-government sponsored program. Participants with dual private and public sources of insurance were classified as having private insurance.

Assessment of Participant Demographics and Risk Factors for CKD Progression

Information on age, sex, and race-ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or all other) was based on self-report during the interview portion of the survey.[14] We ascertained the prevalence of diabetes, hypertension, obesity and overt albuminuria (ACR≥200 mg/g) because these are established risk factors for CKD progression.[15–18] We considered participants to have diabetes if a physician had informed them that they had "sugar diabetes", if they were receiving insulin or an oral hypoglycemic agent, or if they recorded a fasting plasma glucose concentration ≥ 126 mg/dl or a non-fasting plasma glucose concentration ≥ 200 mg/dl.[19] We

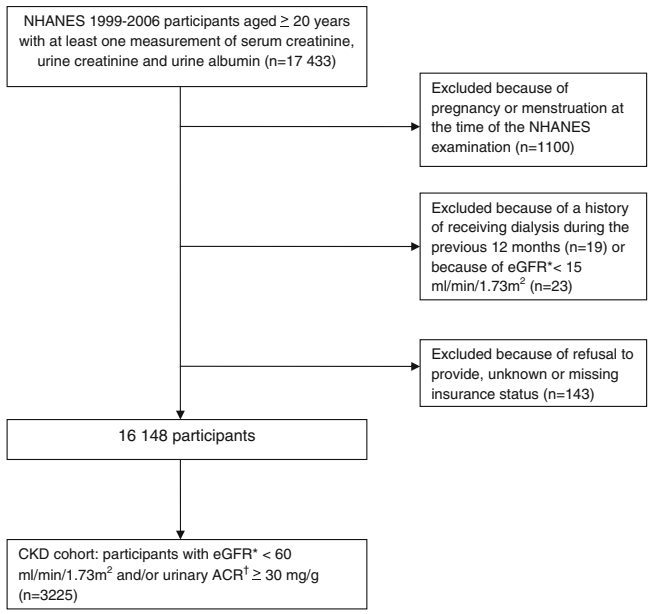

Figure 1. Study flow diagram of NHANES 1999-2006 cohort with chronic kidney disease. *Estimated glomerular filtration rate, †Urinary albumin-to-creatinine ratio.

categorized participants as obese with body mass (Quetélet's) index (calculated as weight in kilograms divided by height in meters squared) ≥ 30 kg/m^2. We considered participants to have hypertension if they reported taking a prescribed anti-hypertensive agent or if their blood pressure was above currently recommended treatment targets for persons with CKD (i.e., if their systolic blood pressure was ≥ 130 mmHg or if their diastolic blood pressure was ≥ 80 mmHg at the time of the examination).[20,21]

Assessment of Hypertension Treatment and Angiotensin Inhibitor Use

Because hypertension is a key risk factor for the progression of CKD, we further assessed the prevalence of anti-hypertensive medication treatment according to health insurance coverage.[15,16,22] We considered participants to be "treated" for their hypertension if they reported that they were currently taking medication to lower blood pressure.[14]

Angiotensin converting enzyme inhibitors (ACEI) and angiotensin II receptor antagonists (ARB) slow the progression of CKD and reduce albuminuria.[5–8] In the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure, CKD is recognized as a compelling indication for the use of these agents to treat hypertension.[20] We assessed prevalence of ACEI or ARB use among hypertensive participants with CKD based on individual responses to the prescription medication questionnaire. During the NHANES interview, participants were asked to show the interviewer the medication containers of all the products used. If no container was available, the interviewer asked the participant to verbally report the name of the medication.

Statistical Analysis

All analyses were conducted using NHANES sample weights, which adjust for the complex survey design, non-response, over-sampling of low-income individuals and racial-ethnic minorities, and post-stratification to yield nationally representative estimates.[11] All analyses account for the survey's complex design (weights, stratification, and clustering) and were performed with Stata Statistical Software (Version SE 10.0, Stata Corp, College Station, TX) using the *svy* command prefix and the *subpop* option.

We described participant characteristics using standard means and frequency analyses. We compared the characteristics of uninsured and insured participants with non-dialysis dependent CKD, including the proportion of participants who had risk factors for progressive CKD, using the chi-square test for categorical variables and the Student's t-test for continuous variables. We further assessed the proportion of hypertensive participants who were receiving treatment for hypertension and the proportion of hypertensive individuals who were receiving ACEI or ARB based on the presence and type of health insurance coverage.

To examine the independent associations of health insurance coverage, treatment of hypertension and ACEI or ARB use, we fitted a series of logistic regression models that adjusted for potential confounders to calculate adjusted odds ratios (and associated 95% confidence limits). The final model included age, sex, race-ethnicity, health insurance coverage, CKD stage, diabetes, obesity and overt albuminuria. We used the post-estimation command *svylogitgof* to assess model fit and we used the Wald test to assess for whether associations differed by age category, sex or race-ethnicity. Two-tailed P-values <0.05 were considered statistically significant.

RESULTS

Patient Characteristics and Health Insurance Coverage

The study population (n=16,148) was representative of more than 182 million US adults aged 20 years or older. Overall, an estimated 15.4% (95% CI, 14.5%-16.2%) of participants, representing approximately 28 million US adults, had non-dialysis dependent CKD based on the presence of either reduced eGFR (15-60 ml/min/1.73 m^2) and/or urinary ACR≥30 mg/g. Approximately 10.0% (95% CI, 8.3%-12.0%) of these individuals were uninsured. Among those reporting health insurance coverage (including those who reported more than one source of health insurance coverage) 67.8% were covered by private health insurance, 51.1% by Medicare, 8.1% by Medicaid, and 8.8% by other government insurance. Uninsured persons with non-dialysis dependent CKD were more likely to be younger than 50 and nonwhite (P<0.001 for both comparisons) compared to those with coverage. They were also more likely to have earlier stage CKD than their insured counterparts (Table 1). Uninsured adults accounted for 23.3% of all persons with non-dialysis dependent CKD who were under the age of 50 and for 5.6% of all whites, 34.0% of all Hispanics, 13.3% of all blacks, and 19.6% of all persons from other racial-ethnic groups with non-dialysis dependent CKD.

Modifiable Risk Factors for CKD Progression

Approximately two-thirds (66.0%) of uninsured adults with non-dialysis dependent CKD had at least one risk factor and 61.7% had at least two risk factors for CKD progression, including 56.6% with hypertension, 39.8% who were obese, 21.5% with diabetes, and 13.3% with overt albuminuria (ACR≥200 mg/g). The prevalence of diabetes, obesity and overt albuminuria did not differ among persons with and without insurance (Table 2). The prevalence of hypertension was lower among uninsured compared to insured persons, largely due to differences in age between the groups (P=0.80 after adjustment for age).

Interventions to Slow CKD Progression

Compared to hypertensive adults with non-dialysis dependent CKD covered by health insurance, those who were uninsured were less likely to be treated for their hypertension and less likely to be receiving an ACEI or ARB. In analyses adjusted for age, sex, race-ethnicity, health insurance status, CKD stage, diabetes, obesity, and overt albuminuria, uninsured persons were still less likely to be treated for their hypertension or to be receiving an ACEI or ARB compared with those with health insurance (Table 3).

In crude and adjusted analyses in which health insurance was further categorized into private and public sources, uninsured persons with non-dialysis dependent CKD were less likely to be treated for hypertension (adjusted OR [95% CI]: 0.61 [0.41-0.91] vs. private and 0.51 [0.35-0.74] vs. public insurance) and less likely to be receiving an ACEI or ARB

Table 1. Demographic Characteristics and Health Insurance Status of US Adults with Non-dialysis Dependent Chronic Kidney Disease

Characteristic*	Insured	Uninsured	P-value†
	% (95% CI)	% (95% CI)	
	(n=2892)	(n=333)	
Race-ethnicity			<0.001
White	78.2 (74.9, 81.0)	41.3 (33.9, 49.0)	
Black	9.8 (8.0, 11.9)	13.6 (9.6, 18.8)	
Hispanic	7.6 (5.6, 10.3)	35.4 (28.3, 43.3)	
Other	4.5 (3.5, 5.7)	9.8 (5.7, 16.1)	
Age, mean, *years*	62.5 (61.6, 63.5)	44.1 (42.0, 46.1)	<0.001
Age category			<0.001
20-49 years	23.0 (20.5, 25.7)	62.8 (56.3, 68.9)	
50-64 years	24.6 (22.3, 27.1)	33.2 (27.3, 39.6)	
≥65 years	52.4 (50.0, 54.9)	4.0 (2.3, 6.9)	
Female	58.6 (56.6, 60.5)	58.0 (51.7, 64.1)	0.88
CKD stage			<0.001
Stages 1–2	44.4 (41.7, 47.3)	76.9 (70.3, 82.4)	
Stage 3	53.2 (50.3, 56.0)	22.0 (16.8, 28.3)	
Stage 4	2.3 (1.8, 3.0)	1.1 (0.2, 4.9)	

**Data estimated from the National Health and Nutrition Examination Survey (1999–2006)*
†P-value comparing uninsured and insured participants with non-dialysis dependent CKD

compared to those with private or those with public health insurance (adjusted OR [95% CI]: 0.45 [0.27-0.76] vs. private and 0.45 [0.25-0.82] vs. public insurance). In adjusted analyses, there were no significant differences in the likelihood of receiving treatment for hypertension or the likelihood of receiving an ACEI or ARB between persons with private versus public health insurance.

DISCUSSION

The federal Medicare ESRD program provides public health insurance for ESRD at a cost of nearly 23 billion dollars annually, or approximately $66,000 per patient per year.[4] At present there is no analogous system of public health coverage for persons with earlier stages of CKD who are younger than 65 but do not qualify for Medicare because of disability. Our results demonstrate that approximately 61% of US adults with non-dialysis dependent CKD are covered by private health insurance, 29% by public health insurance alone, and 10%, or almost 3 million adults, are uninsured. Because many persons with non-dialysis dependent CKD who lack health insurance are young and nonwhite they are at particularly high risk for disease progression. Nevertheless, uninsured Americans with CKD are less likely than their insured counterparts to receive treatments that are currently recommended to slow disease progression despite a similarly high prevalence of modifiable risk factors for disease progression. Thus, despite a substantial public commitment to coverage for end-stage renal disease under the Medicare ESRD program, lack of universal health insurance coverage for persons with non-dialysis dependent CKD most likely translates into missed opportunities to reduce the overall public burden of ESRD, particularly among racial-ethnic minority groups.

Table 2. Prevalence of Modifiable Risk Factors for Chronic Kidney Disease Progression and Health Insurance Status among US Adults with Chronic Kidney Disease

Risk factor*	Insured	Uninsured	P - value‡
	% (95% CI)	% (95% CI)	
	(n=2892)	(n=333)	
Albuminuria			
ACR† ≥ 30 mg/g	58.8 (56.0, 61.6)	80.8 (74.5, 85.8)	<0.001
ACR† ≥ 200 mg/g	11.5 (10.1, 13.0)	13.3 (9.3, 18.6)	0.37
Diabetes	23.9 (21.7, 26.2)	21.5 (16.5, 27.4)	0.65
Hypertension	73.4 (77.1, 81.5)	56.6 (48.1, 64.8)	<0.001
Obesity	40.4 (37.6, 43.3)	39.8 (33.6, 46.3)	0.83

**Data estimated from the National Health and Nutrition Examination Survey (1999–2006). Hypertension was defined as current anti-hypertensive medication use, or systolic blood pressure ≥ 130 mmHg or diastolic blood pressure ≥ 80 mmHg; diabetes was defined as previous diagnosis of or current medication use for diabetes, or fasting plasma glucose concentration ≥ 126 mg/dl or non-fasting plasma glucose concentration ≥ 200 mg/dl; obesity was defined as body mass index ≥ 30.0 kg/m^2*
†Urinary albumin-to-creatinine ratio
‡P-value comparing uninsured and insured participants with non-dialysis dependent CKD

Table 3. Odds Ratios of Hypertension Treatment† and ACEI or ARB Use among Uninsured Versus Insured Hypertensive US Adults with Chronic Kidney Disease

Outcome	Unadjusted OR (95% CI)	Adjusted OR* (95% CI)
Hypertension treatment†	0.44 (0.31, 0.62)	0.59 (0.40, 0.85)
ACEI or ARB use	0.34 (0.20, 0.59)	0.45 (0.26, 0.77)

†Treated: We considered hypertensive participants to be "treated" for hypertension if they reported that they were currently taking medication to lower blood pressure
**Adjusted for age, sex, race-ethnicity, health insurance status, CKD stage, diabetes, obesity, and overt albuminuria*

Largely reflecting the availability of public health coverage for older persons under Medicare, uninsured Americans with CKD are on average 18 years younger than insured persons with CKD. Nearly two-thirds are under 50 and over 85% are under 60. While CKD is more common among older individuals, when CKD occurs in young persons, it is far more likely to progress to ESRD.[23,24] This phenomenon occurs in part because the competing risk of death is much lower among younger compared with older persons with CKD.[24,25] Rates of GFR decline may also be faster in younger compared with older persons with CKD.[23] Thus, because of their much younger age, uninsured Americans with CKD are substantially more likely to progress to ESRD than their insured counterparts.

In addition to being younger, uninsured persons with CKD are more likely to be nonwhite compared with their insured counterparts. Nonwhite race is a well established risk factor for progression *of CKD* to ESRD.[26–30] In the US, the risk of developing ESRD is approximately fourfold higher among blacks, twofold higher among Asians, and 1.5-fold higher among Hispanics relative to non-Hispanic whites even after adjusting for age, sex, educational attainment, baseline kidney function, and modifiable risk factors for CKD progression.[4,26,29] These marked racial-ethnic differences in risk of progression to ESRD are poorly understood but may in part reflect differences in access to care. Consistent with this possibility, data from the United States Renal Data System indicate that 11.4% of all blacks, 39.7% of all Hispanics and 8.2% of all Asians and Pacific Islanders who initiate dialysis

lack health insurance at the onset of ESRD compared with 5.8% of all whites.[4]

We observed a high prevalence of modifiable risk factors for CKD progression, particularly hypertension and obesity, among both insured and uninsured persons with CKD. However, uninsured persons were much less likely than their insured counterparts to be receiving recommended treatments to slow progression of CKD. For example, hypertension treatment and ACEI/ARB use were much lower among uninsured persons with hypertension than among their insured counterparts. Over one-half of uninsured adults with non-dialysis dependent CKD were untreated for their hypertension compared with one-third of those with coverage, and only 18% reported ACEI or ARB use compared with 38% of their insured counterparts. The high prevalence of hypertension and obesity among uninsured persons with CKD underlines the particular importance for this group of public health efforts targeted at these conditions.[33]

LIMITATIONS

Our study's strengths included analysis of a nationally representative sample of US adults with moderate to severe CKD, including the uninsured—a population rarely captured in most studies. Our study also had several limitations. First, we ascertained insurance status based on patient self-report. While we were unable to verify insurance status, our estimates for insurance rates among the study population closely resemble those from the Current Population Study.[1] Second, the study's cross-sectional design did not allow us to establish a causal relationship between health insurance status and the likelihood of receiving recommended interventions to prevent CKD progression. Third, data were unavailable to assess the proportion of participants who had medications available for review by NHANES interviewers. Hence, we cannot rule out the possibility of participant recall bias. Fourth, the small absolute number of uninsured participants with CKD limited our ability to perform stratified analyses or to fully adjust for potential confounders of the association between insurance status and health outcomes. Fifth, some populations at increased risk for lacking health insurance coverage, such as the homeless or the marginally housed and persons without legal US residence were unlikely to have been contacted for participation in NHANES. NHANES also limits participation to persons who speak English or Spanish. Thus, our results may underestimate the proportion of all US adults with CKD who are uninsured. We were also unable to assess risk factors for progressive CKD among uninsured adults who did not speak either English or Spanish. Finally, National Kidney Foundation Kidney Disease Outcomes Quality Initiative defines CKD based on the presence of a low eGFR or kidney damage for at least three months. However, participants in this study were classified as having CKD based on a single estimation of GFR or urinary ACR because repeat measurements at least three months later were not available.

CONCLUSIONS

Approximately 2.8 million US adults with non-dialysis dependent CKD lack health insurance. These individuals are disproportionately young and nonwhite placing them at high risk for progression to ESRD. However, they are much less likely than their counterparts with insurance to be receiving recommended interventions to slow progression of CKD despite a similarly high prevalence of hypertension and obesity - modifiable risk factors for progression to ESRD. These findings suggest that piecemeal coverage for earlier stages of CKD ultimately translates into missed opportunities to prevent CKD progression and thereby reduce the public burden of ESRD.

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Conflicts of Interest: *None disclosed.*

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