CKD in the United States: Kidney Early Evaluation Program (KEEP) and National Health and Nutrition Examination Survey (NHANES) 1999-2004

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Background: The prevalence of chronic kidney disease (CKD) is increasing in the United States, caused in part by older age and increasing prevalences of hypertension and type 2 diabetes. CKD is silent and undetected until advanced stages. The study of populations with earlier stages of kidney disease may improve outcomes of CKD.

Methods: The Kidney Early Evaluation Program (KEEP), a National Kidney Foundation program, is a targeted community-based health-screening program enrolling individuals 18 years and older with diabetes, hypertension, or family history of kidney disease, diabetes, or hypertension. Participants who had received transplants or were on regular dialysis treatment were excluded from this analysis. The National Health and Nutrition Examination Survey (NHANES) 1999-2004 was a nationally representative cross-sectional survey; participants were interviewed in their homes and/or received standardized medical examinations in mobile examination centers.

Results: Of the 61,675 KEEP participants, 16,689 (27.1%) were found to have CKD. In the NHANES sample of 14,632 participants, 2,734 (15.3%) had CKD. Older age, smoking, obesity, diabetes, hypertension, and cardiovascular disease were associated significantly with CKD in both KEEP and NHANES ($P < 0.05$ for all). Of note, the likelihood for CKD in African Americans differed between KEEP (odds ratio, 0.81; $P < 0.001$) and NHANES (odds ratio, 1.10; $P = 0.2$).

Conclusion: A greater prevalence of CKD was detected in the KEEP screening than in the NHANES data. KEEP has the limitations common to population-screening studies and conclusions for population-attributable risk may be limited. The targeted nature of the KEEP screening program and the large sample size with clinical characteristics comparable to NHANES validates KEEP as a valuable cohort to explore health associations for the CKD and at-risk-for-CKD populations in the United States.

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INDEX WORDS: Chronic kidney disease; Kidney Early Evaluation Program (KEEP); National Health and Nutrition Examination Survey (NHANES); screening.

Chronic kidney disease (CKD) is increasingly common in the United States. With the exponential growth of type 2 diabetes mellitus and other risk factors in developed and developing countries, it has become evident that CKD is now a global public health problem. In 2000, approximately 400,000 people were treated by means of kidney replacement therapy (dialysis or transplantation) for end-stage renal disease (ESRD) in the United States.[1] By 2030, this number is expected to increase to more than 2 million.[2] The estimated prevalence of earlier CKD stages (stages 1 through 4) in US adults was 24 to 28 million in 2000 based on the

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National Health and Nutrition Examination Survey (NHANES).[3]

The most common risk factors for CKD include type 2 diabetes mellitus, hypertension, cardiovascular disease (CVD), family history of CKD, and age older than 60 years.[4,5] Major outcomes of CKD include CVD, progression to kidney failure, and development of complications of impaired kidney function, such as anemia, disorders of mineral metabolism, and secondary hyperparathyroidism.[4,6,7] Collectively, these outcomes contribute to overall high mortality and a significant health care burden associated with CKD.[6,7]

CKD usually is silent and undetected until advanced stages; in many patients, CKD is detected only shortly before the onset of symptomatic uremia, when opportunities to prevent adverse outcomes are few.[8] Detection of CKD at earlier stages would allow more time for evaluation and treatment. To identify individuals at greatest risk of CKD and provide screening for early CKD, the Kidney Early Evaluation Program (KEEP) was developed by the National Kidney Foundation.[9,10] KEEP is a voluntary free community-based health-screening program designed to raise awareness and detection of kidney disease in high-risk adult individuals, those with diabetes mellitus and hypertension or a first-order relative who has diabetes, hypertension, or kidney disease. KEEP participants are recruited for the program based on their increased risk.

In this report of the KEEP database, we sought to define baseline characteristics of the CKD population and attendant risk factors and compare them with NHANES 1999-2004, a representative sample of CKD in the US general population. NHANES participants are randomly selected and then volunteer to participate.

METHODS

KEEP and NHANES Study Participants

We included only eligible KEEP participants from August 2000 through December 31, 2006, from 47 National Kidney Foundation affiliates and 1,608 screening programs in 49 states and the District of Columbia. The KEEP study cohort, excluding individuals with missing data values, included 73,460 eligible KEEP participants. After excluding participants with missing values for CKD status, the KEEP study sample size was 61,675. For comparison purposes with KEEP data, all samples analyzed using data collected in NHANES 1999-2004 were restricted to individuals 18 years or older (n = 17,061). For all analyses using smoking status or self-reported CVD, the NHANES study population was limited to participants 20 years or older (n = 15,332) because of data limitations. The KEEP program and the NHANES database are fully described elsewhere in this supplement.[11]

Definitions

To ensure consistent and unbiased comparisons between participants from KEEP and NHANES, we applied common definitions for comorbid conditions included in the analyses. Estimated glomerular filtration rate (eGFR) was calculated using the isotope dilution mass spectrometry 4-variable Modification of Diet in Renal Disease Study equation,[12] and serum creatinine was calibrated to the Cleveland Clinic Research Laboratory.[13] Albumin-creatinine ratios (ACRs) were calculated from urine samples and recorded as less than 30, 30 to 300, or greater than 300 mg/g. CKD stages were defined as follows: stage 1, eGFR greater than 90 mL/min/1.73 m^2 (>1.5 mL/s/1.73 m^2) and ACR of 30 mg/g or greater; stage 2, eGFR of 60 to 89 mL/min/1.73 m^2 (1.00 to 1.48 mL/s/1.73 m^2) and ACR of 30 mg/g or greater; stage 3, eGFR of 30 to 59 mL/min/1.73 m^2 (0.50 to 0.98 mL/s/1.73 m^2); stage 4, eGFR of 15 to 29 mL/min/1.73 m^2 (0.25 to 0.48 mL/s/1.73 m^2); and stage 5, eGFR less than 15 mL/min/1.73 m^2 (<0.25 mL/s/1.73 m^2).

Diabetes was defined as history of diabetes (self-report or retinopathy), use of medications to treat diabetes, or newly diagnosed diabetes defined as fasting blood glucose level greater than 125 mg/dL (>6.9 mmol/L) or nonfasting blood glucose level greater than 200 mg/dL (>11.1 mmol/L) in the absence of self-report or medicine use. Hypertension was defined as history of hypertension (self-report), use of medications to treat hypertension, or newly diagnosed hypertension (Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure),[14] defined as systolic blood pressure of 130 mm Hg or greater or diastolic blood pressure of 80 mm Hg or greater for persons with a history of diabetes or CKD; otherwise, systolic blood pressure of 140 mm Hg or greater or diastolic blood pressure of 90 mm Hg or greater.

History of CVD was defined as self-reported history of heart attack, heart angioplasty, bypass surgery, heart failure, abnormal heart rhythm, or stroke. NHANES defined history of CVD as self-reported history of coronary heart disease, angina/angina pectoris, heart attack, congestive heart failure, or stroke. Obesity was defined as body mass index (BMI) of 30 kg/m^2 or greater.

Statistical Analysis

The overall prevalence of CKD in KEEP and NHANES participants and risk factors for CKD were determined. Logistic regression was used to analyze the association of CKD in risk-factor conditions. Controlled risk factors in the logistic regression were age, sex, race, smoking history, obesity, and self-reported hypertension, diabetes, and CVD. SUDAAN (Research Triangle Institute, Research Triangle Park, NC) was used in all NHANES-related analyses. *P* less than 0.05 is considered statistically significant.

Table 1. Demographic Characteristic Distribution by CKD Status

	Cohort			
	KEEP		NHANES 1999-2004	
Characteristics	CKD	Non-CKD	CKD	Non-CKD
No. of participants	16,689	44,986	2,734	11,898
Age (y)				
18-30	3.0	9.3	9.4	25.9
31-45	11.6	25.1	13.2	34.1
46-60	28.8	37.5	24.2	25.8
61-75	38.1	22.7	28.4	11.3
>75	18.6	5.4	24.8	2.9
Sex				
Men	29.7	31.8	42.0	49.4
Women	70.3	68.2	58.0	50.6
Race/ethnicity				
White	54.3	45.9	74.3	71.8
African American	28.2	33.7	10.6	10.6
Others	17.4	20.3	15.1	17.6
Hispanic	8.7	12.0	11.0	13.7
Non-Hispanic	91.3	88.0	89.0	86.3
Education				
<High school	19.0	13.6	29.7	19.4
≥High school	81.0	86.4	70.3	80.6
Risk				
Current smoker	10.1	31.0	20.2	25.4
Obesity*	45.6	43.7	36.8	29.7
Diabetes	37.6	23.4	19.3	4.4
Hypertension	70.8	48.3	50.9	21.9
Cardiovascular disease	29.3	17.3	24	5.9
All (%)	100	100	100	100

Note: Categorical values are expressed in percent.

Abbreviations: CKD, chronic kidney disease; KEEP, Kidney Early Evaluation Program; NHANES, National Health and Nutrition Examination Survey.

*Body mass index of 30 kg/m^2 or greater.

RESULTS

The KEEP sample included 61,675 participants and the NHANES sample included 14,632 participants (Table 1). Of KEEP participants, 16,689 (27.1%) were found to have CKD, and of NHANES participants, 2,734 (15.3%). By stage, 1,847 (3.0%) KEEP and 614 (3.2%) NHANES participants were at stage 1; 3,037 (4.9%) KEEP and 682 (4.0%) NHANES participants were at stage 2; 11,172 (18.1%) KEEP and 1,317 (7.5%) NHANES participants were at stage 3, and 633 (1.0%) KEEP and 121 (0.5%) NHANES participants were at stages 4 and 5 (Fig 1). Percentages of KEEP and NHANES participants were similar for age and level of education; a greater proportion of women responded than men. The proportion of white compared with African American respondents was lower in KEEP, and men to women was higher in NHANES. The percentage of obese participants and those with self-reported diabetes, hypertension, or CVD was higher in KEEP.

In participants with eGFR less than 60 mL/min/1.73 m^2 (<1.0 mL/s/1.73 m^2) or ACR of 30 mg/g or greater, increasing prevalence by CKD was seen in both KEEP and NHANES (Table 2). Assessment of comorbid risk factors showed that current smoking and less than high school education were more common in participants with CKD in the NHANES cohort. The prevalence of obese and hypertensive participants with CKD was higher in KEEP, and the prevalence with diabetes or CVD and CKD was slightly higher in NHANES.

In KEEP, there was a trend toward decreased prevalence of obesity with higher CKD stages

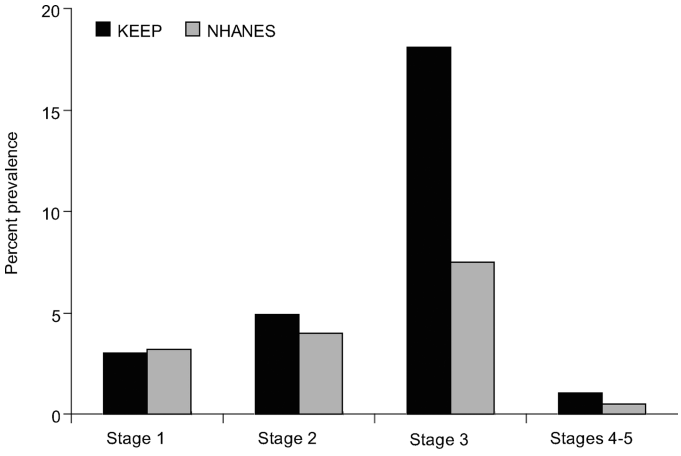

Figure 1. Participants detected with chronic kidney disease by stage in Kidney Early Evaluation Program (KEEP) and National Health and Nutrition Examination Survey (NHANES). Chronic kidney disease stages were defined as follows: stage 1, estimated glomerular filtration rate (eGFR) greater than 90 mL/min/1.73 m^2 and albumin-creatinine ratio (ACR) of 30 mg/g or greater; stage 2, eGFR of 60 to 89 mL/min/1.73 m^2 and ACR of 30 mg/g or greater; stage 3, eGFR of 30 to 59 mL/min/1.73 m^2; stage 4, eGFR of 15 to 29 mL/min/1.73 m^2; and stage 5, eGFR less than 15 mL/min/1.73 m^2. To convert eGFR from mL/min/1.73 m^2 to mL/s/1.73 m^2, multiply by 0.01667.

(stage 1, n = 967 [53.6%]; stage 2, n = 1,422 [47.8%]; stage 3, n = 4,840 [43.9%]; stage 4, n = 213 [41.1%]; and stage 5, n = 41 [39.8%]; Fig 2). Conversely, participants with more severe CKD stages had greater prevalences of hypertension and CVD (stage 1, n = 1,015 [55.4%] hypertension; n = 366 [19.8%] CVD; stage 2, n = 2,011 [66.9%] hypertension; n = 833 [27.4%] CVD; stage 3, n = 8,081 [73.3%] hypertension; n = 3,392 [30.4%] CVD; stage 4, n = 477 [91.4%] hypertension; n = 250 [47.3%] CVD; and stage 5, n = 94 [89.5%] hypertension; n = 45 [42.9%] CVD). A consistent trend was not observed for diabetes (stage 1, n = 763 [41.7%]; stage 2, n = 1,250 [41.7%]; stage 3, n = 3,877 [35%]; stage 4, n = 271 [51.8%]; and stage 5, n = 48 [46.2%]).

Analysis of characteristics of patients with CKD in both KEEP and NHANES found increasing age, smoking, obesity, diabetes, hypertension, and CVD to be significantly associated with CKD ($P < 0.05$ for all; Table 3). Of note, the likelihood for CKD in African Americans differed between KEEP (odds ratio, 0.81; $P < 0.001$) and NHANES (odds ratio, 1.10; $P = 0.2$). For the KEEP screening variables, there was a graded relationship between serum glucose level, systolic blood pressure, intact parathyroid hormone level, and serum phosphorous level with CKD stage (Table 4).

DISCUSSION

In volunteer KEEP screening participants who were identified with CKD, we found similar associations of the prevalence of obesity, diabe-

Table 2. Percent Prevalence of CKD by Risk Group

	Chronic Kidney Disease			
	KEEP		NHANES 1999-2004	
	No. of Participants	%	No. of Participants	%
Age (y)				
18-30	503	10.7	261	6.1
31-45	1,932	14.6	261	6.5
46-60	4,802	22.2	421	14.4
61-75	6,356	38.4	870	31.1
>75	3,096	56.1	921	60.9
Sex				
Men	4,961	25.8	1,255	13.3
Women	11,728	27.7	1,479	17.1
Race/ethnicity				
White	9,069	30.5	1,519	15.7
African American	4,709	23.7	501	15.2
Others	2,911	24.1	714	13.4
Hispanic	1,446	21.1	641	12.7
Non-Hispanic	15,243	27.8	2,093	15.7
Education				
<High school	3,125	34.1	1,118	21.6
≥High school	13,304	25.7	1,608	13.6
Risk				
Current smoker	1,584	23.1	442	12.8
Obesity*	7,483	27.9	917	17.9
Diabetes	6,209	37.2	629	44.3
Hypertension	11,678	35.3	1,476	29.5
Cardiovascular disease	4,886	38.5	727	42.7
All†	16,689	27.1	2,734	15.3

Abbreviations: KEEP, Kidney Early Evaluation Program; NHANES, National Health and Nutrition Examination Survey.

*Body mass index of 30 kg/m^2 or greater.

†Excluding missing value for estimated glomerular filtration rate.

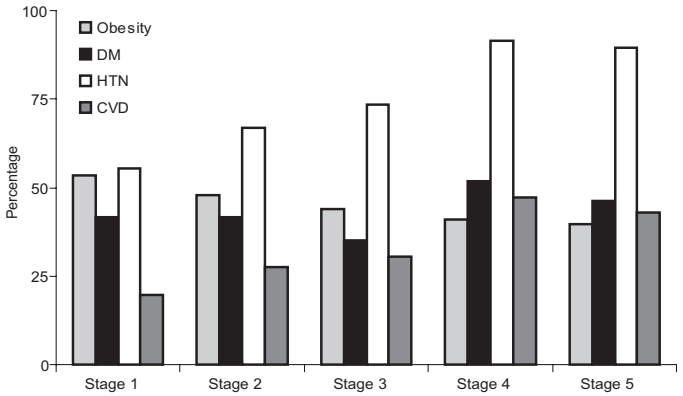

Figure 2. Chronic kidney disease risk factors in the Kidney Early Evaluation Program. Percentages of self-reported characteristic risk factors grouped by stage. Chronic kidney disease stages were defined as follows: stage 1, estimated glomerular filtration rate (eGFR) greater than 90 mL/min/1.73 m^2 and albumin-creatinine ratio (ACR) of 30 mg/g or greater; stage 2, eGFR of 60 to 89 mL/min/1.73 m^2 and ACR of 30 mg/g or greater; stage 3, eGFR of 30 to 59 mL/min/1.73 m^2; stage 4, eGFR of 15 to 29 mL/min/1.73 m^2; and stage 5, eGFR less than 15 mL/min/1.73 m^2. To convert eGFR from mL/min/1.73 m^2 to mL/s/1.73 m^2, multiply by 0.01667. Abbreviations: DM, diabetes mellitus; HTN, hypertension; CVD, cardiovascular disease.

tes, hypertension, and CVD in KEEP and NHANES participants, as well as significant age-related increases in rates of CKD. The greater percentages of women and high school graduates who participated in KEEP likely reflect the effect of differences in recruitment strategies. The KEEP program may represent a higher risk and more motivated patient population than NHANES because of the nature of the KEEP screening program. KEEP screening results are consistent with

Table 3. Odds Ratios for Chronic Kidney Disease

	Cohort			
	KEEP		NHANES 1999-2004	
Characteristics	Odds Ratio (95% confidence interval)	*P*	Odds Ratio (95% confidence interval)	*P*
Age (y)				
18-30	0.58 (0.52-0.64)	<0.001	0.51 (0.40-0.67)	<0.001
31-45	0.73 (0.69-0.78)	<0.001	0.51 (0.40-0.64)	<0.001
46-60	1		1	
61-75	1.91 (1.82-2.01)	<0.001	2.25 (1.94-2.62)	<0.001
>75	3.90 (3.64-4.18)	<0.001	8.09 (6.61-9.90)	<0.001
Sex				
Women	1		1	
Men	0.841 (0.81-0.88)	<0.001	0.76 (0.69-0.84)	<0.001
Race				
White	1		1	
African American	0.81 (0.77-0.85)	<0.001	1.10 (0.95-1.26)	0.2
Other	0.97 (0.92-1.03)	0.3	1.26 (1.08-1.48)	0.004
Risk factors				
Current smoking	1.13 (1.06-1.21)	<0.001	1.31 (1.09-1.57)	0.005
Obesity*	1.07 (1.02-1.11)	0.003	1.19 (1.03-1.37)	0.02
Diabetes†	1.45 (1.39-1.52)	<0.001	2.68 (2.17-3.33)	<0.001
Hypertension†	1.71 (1.63-1.79)	<0.001	1.72 (1.51-1.96)	<0.001
Cardiovascular disease†	1.31 (1.25-1.37)	<0.001	1.72 (1.45-2.04)	<0.001

Note: NHANES study population aged 20 years and older.
Abbreviations: KEEP, Kidney Early Evaluation Program; NHANES, National Health and Nutrition Examination Survey.
*Body mass index of 30 kg/m^2 or greater.
†Self-reported.

Table 4. Mean Values of Selected Clinical and Laboratory Screening Data Collected in KEEP

Variable	Chronic Kidney Disease Stage					
	None	1	2	3	4	5
Body mass index (kg/m^2)	30.1 ± 6.8	31.9 ± 8.0	30.7 ± 7.0	30.1 ± 6.5	29.7 ± 6.6	29.0 ± 6.2
Glucose (mg/dL)	112.5 ± 47.5	141.5 ± 81.5	137.0 ± 75.4	121.5 ± 55.9	139.3 ± 69.7	132.0 ± 57.8
Systolic blood pressure (mm Hg)	131.6 ± 19.0	137.2 ± 22.7	141.4 ± 23.3	137.8 ± 21.1	141.8 ± 23.7	148.4 ± 25.1
Diastolic blood pressure (mm Hg)	79.3 ± 11.2	82.7 ± 12.7	81.9 ± 13.0	77.8 ± 11.7	75.0 ± 12.7	81.2 ± 13.1
Total cholesterol (mg/dL)	199.4 ± 40.6	199.1 ± 44.9	200.2 ± 43.0	201.8 ± 44.0	191.8 ± 55.5	191.4 ± 60.2
Estimated GFR (mL/min/1.73 m^2)	87.1 ± 19.1	108.9 ± 20.0	74.8 ± 8.5	50.3 ± 7.4	24.5 ± 4.1	9.8 ± 3.3
Hemoglobin (g/dL)	13.8 ± 1.4	13.5 ± 1.7	13.7 ± 1.6	13.5 ± 1.7	12.2 ± 3.7	11.3 ± 1.8
Intact PTH (pg/mL)*	—	—	—	76.2 ± 48.6	159.9 ± 108.2	190.4 ± 120.3
Phosphorous (mg/dL)	—	—	—	3.7 ± 0.7	4.0 ± 0.7	5.1 ± 1.1
Calcium (mg/dL)	—	—	—	9.5 ± 0.5	9.3 ± 0.5	9.4 ± 1.0

Note: Data expressed as mean ± SD. To convert glucose in mg/dL to mmol/L, multiply by 0.0555; cholesterol in mg/dL to mmol/L, multiply by 0.0259; estimated GFR in mL/min/1.73 m^2 to mL/s/1.73 m^2, multiply by 0.0167; hemoglobin in g/dL to g/L, multiply by 10; phosphorous in mg/dL to mmol/L, multiply by 0.0323; calcium in mg/dL to mmol, multiply by 0.2495. PTH levels expressed in pg/mL and ng/L are equivalent.

Abbreviations: GFR, glomerular filtration rate; PTH, parathyroid hormone; KEEP, Kidney Early Evaluation Program.

*Test for PTH, calcium, and phosphorus is performed only for persons with estimated GFR less than 60 mL/min/1.73 m^2 (<1.00 mL/s/1.73 m^2).

an enriched subset of the general CKD population in the United States as described by NHANES because of the effort to target individuals at high risk of CKD, those with diabetes or hypertension or a first-order relative with diabetes, hypertension, or CKD.

The majority of KEEP participants with CKD had CKD stage 3. This finding is similar to the NHANES population, although the relative proportion is much greater in KEEP. The proportion of KEEP participants who had CKD stage 4 relative to stage 3 was greater than the corresponding proportion of NHANES participants. Recruitment of a high-risk population is a likely explanation for these results.

In general, our data are consistent with previous reports of KEEP data[9,10,15-22] and extend our understanding of the relationship between diabetes, hypertension, CVD, and CKD.[15,17,18] This report suggests that the likelihood of the presence of CKD is greater with increasing age, tobacco use, obesity, and the presence of diabetes, hypertension, or CVD. A strong correlation is well recognized between the presence of diabetes, hypertension, and CKD progression and subsequent CVD outcomes. Not only are nonfatal CVD events more common in patients with CKD than in the general population,[19] but patients with CKD are more likely to die of CVD-related mortality than progress to ESRD.[6]

A previous analysis of KEEP and NHANES III supported this correlation.[15] In the KEEP analysis, the investigators reported a strong relationship between CVD and eGFR less than 60 mL/min/1.73 m^2 (<1.0 mL/s/1.73 m^2), ACR (≥30 mg/dL on a spot urine check), and level of anemia, even after adjustment for multiple demographic characteristics. The data expanded on a previous NHANES analysis in which assessment of CVD risk was based on tobacco use, BMI of 30 kg/m^2 or greater, total cholesterol level of 240 mg/dL or greater (≥6.21 mmol/L), systolic blood pressure of 140 mm Hg or greater or diastolic blood pressure of 90 mm Hg or greater, glycosylated hemoglobin level greater than 8%, hemoglobin level less than 12 g/dL (<120 g/L) in women and less than 13 g/dL (<130 g/L) in men, C-reactive protein level of 1 mg/dL or greater, homocysteine level of 1.49 mg/L or greater (≥11 μmol/L), and random urinary ACR of 30 mg/g or greater. Results were controlled for age, sex, race, smoking status, BMI, self-reported diabetes, self-reported hypertension, self-reported CVD, years of education, income, and insurance coverage. Collective results suggest that the frequency of CVD risk increased with decreasing

kidney function, particularly when eGFR was less than 60 mL/min/1.73 m^2 (<1.0 mL/s/1.73 m^2). These results confirmed data from the Framingham Heart Study that showed associations between increased renal insufficiency (defined as serum creatinine levels of 1.5 to 3.0 mg/dL [133 to 265 μmol/L] in men and 1.4 to 3.0 mg/dL [133 to 265 μmol/L] in women) and diabetes and obesity for men and diabetes, hypertension, former smoking, high total cholesterol level, and obesity for women. Importantly, these cross-sectional studies cannot define causal relationships between CKD and risk factors because they measure only the prevalence of risk factors.

The finding that BMI prevalence remained constant in all stages of CKD and self-reported obesity decreased with advancing CKD stage is particularly interesting and may reflect survival bias or other factors. Previous reports from this group noted trends toward increased obesity in KEEP and NHANES based on sex and race, but obesity had not been explored by staging.[19,21] A correlative association between obesity and CKD was documented through population studies. Previous data from NHANES, in addition to results from the Okinawa Dialysis Study Registry, show a parallel increase in prevalence of obesity and ESRD, suggesting that obesity is an important contributor to CKD.[23,24] Furthermore, after adjusting for the presence of type 2 diabetes mellitus and hypertension, data from the Kaiser Permanente of Northern California's Multiphasic Health Testing Services Program and the US Renal Data System registry suggest an independent increasing risk of ESRD with increasing BMI in kilograms per square meter.[25]

In assessing the risk of CKD as BMI increases, analysis of the Physicians' Health Study showed that individuals in the highest BMI quintile (>26.6 kg/m^2) had an odds ratio of 1.45 (95% confidence interval, 1.19 to 1.76; *P* trend < 0.001) for the development of CKD.[26] Results from the Framingham Offspring Study further suggest that as BMI increased, the risk of new-onset kidney disease increased (odds ratio, 1.23 per 1 SD; 95% confidence interval, 1.08 to 1.41).[27]

KEEP has the limitations common to population-screening studies, and conclusions for population-attributable risk may be limited. Screened participants are volunteers who likely were motivated by their recognized risk of CKD. This may be one reason that results varied by race, sex, and education compared with NHANES. Furthermore, the targeted nature of the KEEP screening may also introduce selection bias favoring earlier stages of CKD as a study sample. However, we believe the targeted nature of the KEEP screening program and the large sample size with clinical characteristics similar to NHANES validates KEEP as a valuable cohort to explore health associations for the CKD and at-risk-for-CKD populations in the United States.

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