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State-Level Awareness of Chronic Kidney Disease in the U.S

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Abstract

Introduction—This study examined state-level variation in chronic kidney disease (CKD) awareness using national estimates of disease awareness among adults in the U.S. with CKD.

Methods—Data on U.S. adults were obtained from two national, population-based surveys: (1) the Behavioral Risk Factor Surveillance System (BRFSS 2011; *n*=506,467), a state-level phone survey containing information on self-reported kidney disease; and (2) the National Health and Nutrition Examination Survey (NHANES 2005–2012; *n*=20,831), containing physical health examination, surveys containing data on self-reported kidney disease, risk factors, and laboratory values. CKD was defined as an estimated glomerular filtration rate of 15–59 mL/minute/1.73 m^2 or urinary albumin-to-creatinine ratio >30 mg/g. As BRFSS does not include laboratory data, CKD status for each person was imputed (multiple) based on a logistic regression model

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predicting NHANES CKD status. CKD awareness in each state was estimated as the weighted proportion of BRFSS participants with imputed CKD who reported having kidney disease.

Results—Overall, estimated CKD awareness was 9.0% (95% CI=8.0%, 10.0%), ranging from 5.8% (95% CI=4.8%, 6.8%) in Iowa to 11.7% (95% CI=9.7%, 13.7%) in Arizona. Awareness was greater among adults with hypertension (12.0%) and diabetes (15.3%) than among adults without those conditions, and lower in Hispanics (6.0%) than in non-Hispanic whites (8.8%), non-Hispanic blacks (9.9%), and other racial/ethnic groups (12.7%).

Conclusions—Among individuals with CKD, awareness of their condition was very low and varied approximately twofold among states. This is the first study to estimate awareness of kidney disease by state for the U.S. adult population.

INTRODUCTION

Chronic kidney disease (CKD) is a silent yet serious condition that often goes undetected until its later stages, even in high-risk subgroups, such as those with diabetes and hypertension.[1] CKD prevalence in the adult U.S. population is estimated at about 14%; in certain groups, such as those aged ≥60 years, prevalence is about 25%.[2–4] Morbidity and mortality are high among individuals with CKD, who in 2011 experienced, on average, 0.43 hospitalizations per patient year and 140 deaths per 1,000 patient years.[2] CKD is associated with increased mortality from cardiovascular disease[5] in particular, and has moved from the 21st (1990) to the 16th (2010) leading cause of premature death and years of life lost.[6,7]

Awareness of CKD is defined as the proportion of people with CKD who are aware of their condition. Analysis of National Health and Nutrition Examination Survey (NHANES) 2005–2012 data demonstrated that only 7.4% of individuals in the U.S. with CKD were aware of their disease.[8] As NHANES was not designed to yield state-specific estimates, the extent of geographic variation in CKD awareness is currently unknown. Knowledge of state-specific CKD awareness could assist public health agencies in directing allocation of resources to areas with greatest public health need. Greater awareness of CKD and its risk factors could lead to reductions in mortality, morbidity, and progression to end-stage renal disease by increasing the likelihood of receiving timely and appropriate health care.[8] As part of the U.S. Centers for Disease Control and Prevention's CKD Surveillance System,[9] this study estimated state-level awareness of CKD using cross-sectional data from two nationally representative surveys: NHANES and the Behavioral Risk Factor Surveillance System (BRFSS).

METHODS

Cross-sectional data derived from two sources were examined: The 2011 BRFSS; and 2005–2006, 2007–2008, 2009–2010, and 2011–2012 waves of NHANES.[10,11] Using logistic regression in a multi-year NHANES sample, CKD status for each BRFSS participant was multiply imputed[10] based on CKD risk factors such as age, race, sex, diabetes, and hypertension status. CKD awareness in each state was estimated as the weighted proportion of BRFSS participants with imputed CKD who reported having kidney disease.[12] All data analyses were conducted during 2014–2016.

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Study Population

The population-based NHANES samples are designed for national inference, not to produce state-based estimates. BRFSS is the world's largest ongoing telephone health survey developed and conducted to monitor state-level prevalence of the major behavioral risks associated with premature morbidity and mortality in adults. The 2005–2012 NHANES data included information from all participants aged ≥18 years. Those who had either missing data for serum creatinine, were pregnant or menstruating at the time of examination, or had received dialysis within 12 months of the survey were excluded from analysis, leaving a sample of 20,831 individuals. The 2011 BRFSS survey included a total of 506,467 individuals aged ≥ 18 years, ranging from 3,543 participants in Alaska to 25,416 in Nebraska. In this study, awareness was estimated for states within the continental U.S., Alaska, and District of Columbia, excluding data from 16,106 residents of Hawaii, Guam, and Puerto Rico.

Measures

Beginning in 2011, BRFSS asked all respondents: *Has a doctor, nurse, or other health professional ever told you that you have kidney disease? Do NOT include kidney stones, bladder infection, or incontinence (incontinence is not being able to control urine flow.)* A *yes* response was categorized as self-reported kidney disease and a *no* or *don't know/not sure* response as no self-reported kidney disease. In addition to the self-report status for CKD, BRFSS data were utilized on self-reported age, sex, race/ethnicity, hypertension, and diabetes as covariates. BRFSS imputes missing race/ethnicity responses based on the geographic region of residence, and missing age responses as the average sample age; the analysis used these BRFSS-provided values.[11] In BRFSS, race/ethnicity was classified as either non-Hispanic white, non-Hispanic black, Hispanic, Asian, Pacific Islander, or Native American. For the purpose of these analyses, Asian, Pacific Islander, and Native American were grouped with other, unknown, or more than one race choices into an "others" category. Hypertension and diabetes status were determined based on the responses to the questions: *Has a doctor, nurse, or other health professional ever told you that you have diabetes?* and *Have you EVER been told by a doctor, nurse, or other health professional that you have high blood pressure?* Respondents answering *yes* were categorized as having the condition (including women who reported having diabetes during pregnancy only) and respondents answering *no* or *don't know/not sure* as not having the condition. As there were only 1,636 (0.33%) respondents with missing information or a *refused* response on questions regarding hypertension, diabetes, or kidney disease, these respondents were excluded from analysis.

Obtained from the NHANES data set was information on age, sex, race/ethnicity, sample weight, and masked variance unit for each individual from the Demographic Variables and Sample Weights data file. Information from the urinary albumin and urinary creatinine components of laboratory data was used to determine CKD status. CKD was defined as estimated glomerular filtration rate (GFR) of 15–59 mL/minute/1.73 m^2 or urinary albumin-to-creatinine ratio >30 mg/g. Two separate analyses were conducted to estimate GFR using equations from the Modification of Diet in Renal Disease (MDRD) Study and the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI). The urine pregnancy test component of the laboratory data identified pregnant survey participants and the kidney

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conditions– urology section of the questionnaire data files identified participants who self-reported kidney disease, but who had received dialysis in the past 12 months. Self-reported kidney disease status was determined as described for BRFSS participants, using the NHANES question: *Has a doctor, nurse, or other health professional ever told you have weak or failing kidneys? Do NOT include kidney stones, bladder infection, or incontinence*. Race was classified in the BRFSS sample. Hypertension and diabetes statuses were determined using the same conventions described for the BRFSS: *Has a doctor, nurse, or other health professional ever told you that you have diabetes?* and *Have you ever been told by a doctor or other health professional that you have hypertension, also called high blood pressure?*

Statistical Analysis

Using survey sample weights, first, state-specific prevalence of self-reported kidney disease was estimated as the weighted proportion of survey respondents with self-reported kidney disease. This proportion was then stratified by age, sex, race/ethnicity, hypertension status, and diabetes status.

As the BRFSS sample did not contain laboratory data, CKD status was multiply imputed for each participant using information on the following covariates: age, sex, race/ethnicity, hypertension, diabetes, and self-reported kidney disease. To impute CKD status in the BRFSS sample, the approach detailed in Schenker et al.[13] was used. In their work, Schenker and colleagues demonstrated the use of information from an examination-based survey such as NHANES to correct estimates of disease prevalence obtained from self-reported health data in large-scale surveys such as BRFSS. First, the BRFSS and the NHANES data were stacked together. Then, a logistic regression model was built relating the aforementioned covariates to CKD status in those individuals where CKD status was observed (i.e., in individuals making up the NHANES samples). From this logistic regression model the predicted probabilities of CKD status for individuals with a missing CKD status were obtained (i.e., individuals in the BRFSS sample). The missing CKD status was imputed using these predicted probabilities. A detailed step-by-step explanation of the imputation procedure is provided in the Appendix (available online). Using IVEware, version 0.2 (www.isr.umich.edu/src/smp/ive/), ten imputations of CKD status were created for each participant in the BRFSS sample. As two different definitions of CKD based on two different estimated GFR equations (CKD-EPI and MDRD) were used, the imputations were carried out twice—once for each CKD definition.

Finally, the awareness of CKD(A_{im}) in state i and imputation m was estimated as the weighted proportion of BRFSS participants with imputed CKD who self-reported kidney disease in state i. Estimates from the different imputations were combined using the standard rules for combining estimates from multiply imputed data sets.[14]

RESULTS

In 2011 BRFSS data, 2.5% (95% CI=2.4%, 2.6%) of the U.S. population reported having been told they have kidney disease. A lower proportion of 2005–2012 NHANES participants reported weak or failing kidneys (1.9%, 95% CI=1.7%, 2.2%). In both samples, self-

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reported kidney disease was highest among adults with diabetes or hypertension and among those aged ≥65 years.

Based on the imputation method applied to the BRFSS sample to project GFR, the prevalence of CKD in the U.S. was estimated to be 14.5% (95% CI=13.9%, 15.1%) using the CKD-EPI equation, and 15.6% (95% CI=15.1%, 16.2%) using the MDRD equation (Table 1). Estimated CKD prevalence was highest among adults with diabetes or hypertension and those aged ≥65 years. Direct estimates of CKD prevalence based on laboratory data in the 2011–2012 NHANES sample were 1.2% lower than those obtained using a multiple imputation method in the BRFSS sample (Table 1).

Awareness of CKD in the U.S. using BRFSS data was estimated at 9.0% (95% CI=8.0%, 10.0%) using the CKD-EPI equation and 8.6% (95% CI=7.7%, 9.5%) using the MDRD equation to estimate GFR (Table 2). From the 2011–2012 NHANES sample containing both survey data (asking about "weak or failing kidneys") and laboratory data, overall CKD awareness was estimated at 9.1% (95% CI=6.2%, 11.9%; CKD-EPI) and 8.5% (95% CI=5.8%. 11.1%; MDRD). Thus, the multiple imputation method yielded estimates of CKD awareness that were similar to the design-based estimates in NHANES, but with potentially greater precision, owing to the larger sample size in BRFSS.

When examining covariate categories, use of CKD-EPI and MDRD equations yielded similar estimates of CKD awareness among imputed CKD cases in BRFSS. Awareness was higher among adults with hypertension (12.0%, CKD-EPI; 11.6%, MDRD) and among those with diabetes (15.3% and 14.7%) compared with those without these conditions. Awareness was lower in Hispanics (6.0% and 5.9%) than in other racial/ethnic groups (Table 3).

Within the continental U.S., Alaska, and the District of Columbia, the state-specific proportion of self-reported kidney disease ranged from 1.5% in Iowa to 3.5% in Arizona (Figure 1, Plot A; Table 3). Other states with the highest proportions of self-reported kidney disease were (in decreasing order) Florida, Oklahoma, New Mexico, and Michigan. The estimated state-specific prevalence of imputed CKD ranged from 11.6% in Utah to 16.7% in Florida, using the CKD-EPI equation (Figure 1, Plot B; Table 3), and from 12.7% in Utah to 17.8% in Florida using the MDRD equation (results not shown). State-specific awareness of CKD among imputed cases ranged from 5.8% in Iowa to 11.7% in Arizona (CKD-EPI; Figure 1, Plot C; Table 3) and from 5.4% in Iowa to 11.1% in Arizona (MDRD; results not shown). Using either equation to estimate GFR, states with the highest levels of CKD awareness were Arizona, New Mexico, Georgia, the District of Columbia, and West Virginia; states with the lowest levels of awareness were Iowa, New Jersey, Minnesota, Maryland, and Massachusetts (Figure 1, Plot C; Table 3).

DISCUSSION

To the authors' knowledge, this work represents the first attempt to examine geographic variation in CKD awareness in the general U.S. population. Estimates from two large U.S. population-based surveys revealed that adult awareness of CKD in the general population is very low. Though variation in the degree of awareness by state was observed, even among

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states with relatively higher awareness, <13% of the general population that has kidney disease was estimated to be aware of their CKD. Any attempt to estimate population awareness of CKD requires identification of those affected. As the data sources did not contain both laboratory data and geographic location information for the same set of individuals, an indirect approach was utilized to estimate both state-level prevalence and awareness of CKD by developing a predictive regression model in a sample with laboratory and clinical data (NHANES), followed by multiple imputation in a population sample with self-reported, but no clinical/laboratory data (BRFSS).

Estimated awareness of CKD was found to vary about twofold among states in 2011. Further, the ranking of states with respect to estimated CKD awareness differed from the ranking of self-reported kidney disease. For example, although Georgia ranked as one of the five most aware states by the imputation method, it ranked 11th in the country with respect to self-reported kidney disease in BRFSS. Such discrepancies perhaps suggest differences in awareness and testing levels among states. Indeed, assuming that the imputation method leads to accurate estimates of state-level prevalence, the rate of self-report observed in Georgia is higher than what would be expected for a state with the corresponding prevalence. This indicates a higher rate of awareness in the state, perhaps driven by higher testing levels and greater access to care.

Using the BRFSS data imputation, overall awareness of CKD in the U.S. was estimated to be 9%. This estimate seems consistent with that reported by previous investigators using data from volunteer participants in the National Kidney Foundation’s Kidney Early Evaluation Program[15–17] and those using NHANES data, with awareness estimates between 6.0% and 9.0%.[18,19]

In BRFSS 2011, the estimated awareness of CKD was higher in men than women, and in adults with diabetes or hypertension versus those without these comorbid conditions. These results were consistent with results from a previous study based on NHANES data.[18] The use of NHANES 2011–2012 data led to estimates of CKD awareness that were similarly higher in the hypertensive and diabetic subgroups, but lower in men than in women. However, the lack of precision in these estimates, based on a single wave of NHANES data, limits the interpretation of subgroup comparisons. The approach produced more-precise estimates of the burden of CKD in the general population. This gain in precision comes without an additional data collection burden, as the method leverages existing data from publicly available data sources, such as NHANES and BRFSS.

As expected, the choice of equation used to estimate GFR influenced the overall estimate of imputed CKD prevalence in the U.S. (14.5% by CKD-EPI equation vs 15.6% by MDRD equation), although this made less of a difference in estimating overall awareness in the U.S. (9.0% CKD-EPI vs 8.6% MDRD) and awareness within risk factor categories. Consistency in estimating awareness is a desirable property of any method with a potential use in surveillance programs.

It should be noted that the questions pertaining to kidney disease in NHANES and BRFSS are worded differently. Whereas the BRFSS question asks *Ever told you have kidney*

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disease?, the NHANES question asks *Ever told you have weak or failing kidneys?* This semantic difference may have affected the responses of participants, with 2.5% of participants in the BRFSS sample answering *yes* compared with 1.9% of NHANES participants. As self-reported information was used to multiply impute CKD status for BRFSS participants, prevalence estimates were 1.2% higher than the corresponding direct estimates obtained using 2011–2012 NHANES data (Table 2). However, the difference in question wording seemed to have no effect on estimates of CKD awareness. In fact, estimates based on the imputation method were nearly identical to the direct estimates based on 2011–2012 NHANES data, with the added advantage of being more precise (Table 2).

Limitations

The main limitations of this study are the assumptions involved in the estimation of CKD awareness. Although the authors' method produces estimates with improved precision compared with direct survey-based estimates from NHANES, as with any imputation-based quantity, these estimates may be biased if the underlying imputation model is incorrect. A gain in precision, however, does not equate to a gain in accuracy. In building a model to predict CKD using NHANES data, it was assumed that the NHANES assessment of CKD was accurate and that the authors' model predicting CKD status was properly specified and did not exclude any important predictors of CKD. Further, it was assumed that CKD status in BRFSS participants was missing at random; that is, it was assumed that given the covariates used in the model, the missing data or lack of information on CKD status for BRFSS participants did not depend on the actual CKD status of these individuals and could be derived from the available information on covariates.

Although the two survey samples were probability samples of the U.S. population, they may represent slightly different source populations. For example, BRFSS is a telephone survey but NHANES is not, and though participants in both surveys were asked similar interview questions, participants in the NHANES are given laboratory tests following their interview, which may influence their answers. Thus, a single "global" regression model built using all the NHANES data may not capture the true relation between clinical CKD and its risk factors for all participants in the BRFSS sample. This raises concerns about the portability of the imputation model, that is, whether the model fitted to the NHANES data can be applied to the BRFSS data to predict clinical disease status. This concern is addressed in the imputation approach by fitting separate "local" imputation models in different regions of the covariate space; that is, the combined data of NHANES and BRFSS samples were divided into subgroups for which the distributions of the covariates were similar across the two surveys, and then the imputations were carried through separate regression models fitted within each subgroup.

CONCLUSIONS

The results suggest that among adults with CKD, awareness of the condition is very low and varies about twofold among U.S. states. This appears to be the first report that provides an efficient method to estimate both CKD prevalence and CKD awareness at the state level without an additional data collection burden, leveraging existing data from two large, probability samples of the U.S. population: NHANES and BRFSS. The study presents a quantitative approach to indirectly estimate the awareness of CKD among individuals with the condition at the state level in the absence of laboratory information on patient CKD status. This approach could be applied to CKD surveillance programs to study geographic variation and trends in CKD awareness across the U.S. and to understand factors underlying those variations. Future research should focus on validating (by state-level data collection) and examining CKD awareness at even more geographically granular levels.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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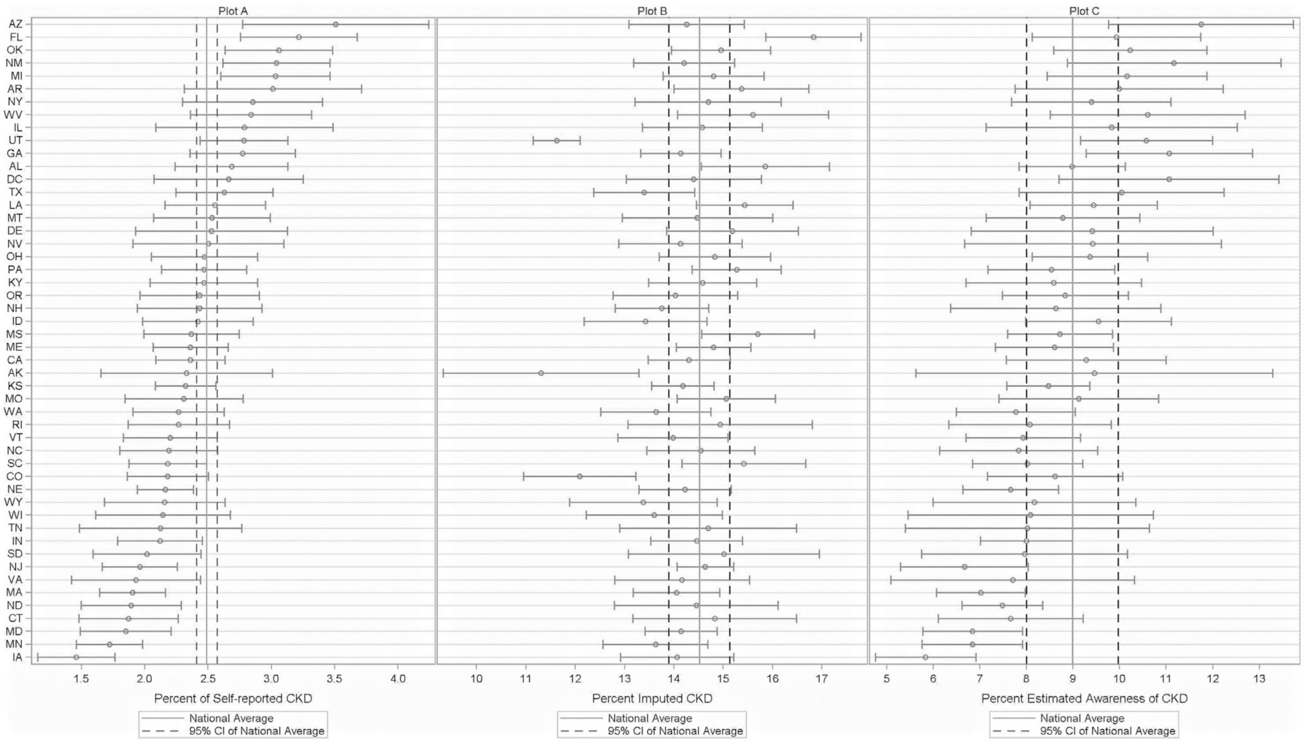

Figure 1.

Mean and 95% CI of self-reported CKD in the BRFSS (Plot A), imputed prevalence of CKD (Plot B) and estimated CKD awareness among imputed cases (Plot C), by state, using CKD-EPI equation to estimate GFR.

CKD, chronic kidney disease; BRFSS, Behavioral Risk Factor Surveillance System; CKD-EPI, CKD Chronic Kidney Disease Epidemiology Collaboration Equation; GFR, glomerular filtration rate.

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Table 1

Estimated U.S. CKD Prevalence Using NHANES and BRFSS, by Equation Estimating GFR and Covariate Category

	GFR estimate MDRD equation		GFR estimate CKD-EPI equation	
Characteristics	**NHANES 2011–2012 (*n*=5,055)**	**Imputed BRFSS 2011 (*n*=506,467)**	**NHANES 2011–2012 (*n*=5,055)**	**Imputed BRFSS 2011 (*n*=506,467)**
Overall	14.4 (12.5, 16.3)	15.6 (15.1, 16.2)	13.3 (11.6, 15.1)	14.5 (13.9, 15.1)
Age, years				
<65	8.4 (6.8, 10.0)	10.0 (9.5, 10.6)	8.4 (6.8, 10.0)	8.9 (8.4, 9.5)
≥65	37.6 (35.1, 40.1)	41.5 (39.7, 43.2)	37.6 (35.1, 40.1)	40.4 (38.5, 42.3)
Race				
Non-Hispanic white	13.1 (10.9, 15.3)	15.8 (15.1, 16.4)	13.1 (10.9, 15.3)	14.4 (13.7, 15.1)
Non-Hispanic black	16.9 (14.7, 19.1)	16.1 (15.2, 17.0)	16.9 (14.7, 19.1)	16.4 (15.4, 17.4)
Hispanic	12.5 (9.2, 15.8)	12.8 (10.7, 14.9)	12.5 (9.2, 15.8)	12.4 (10.3, 14.4)
Others	12.4 (8.7, 16.0)	14.0 (11.9, 16.1)	12.4 (8.7, 16.0)	13.5 (11.4, 15.7)
Sex				
Male	12.2 (9.6, 14.7)	12.8 (11.8, 13.7)	12.2 (9.6, 14.7)	12.4 (11.4, 13.5)
Female	14.5 (12.8, 16.2)	18.3 (17.9, 18.7)	14.5 (12.8, 16.2)	16.5 (16.0, 17.0)
Diabetes				
No	10.7 (9.2, 12.2)	12.7 (12.2, 13.2)	10.7 (9.2, 12.2)	11.7 (11.1, 12.2)
Yes	35.7 (30.5, 40.9)	39.5 (37.4, 41.5)	35.7 (30.5, 40.9)	37.9 (35.8, 40.1)
Hypertension				
No	8.1 (6.5, 9.7)	9.5 (8.9, 10.1)	8.1 (6.5, 9.7)	8.6 (8.0, 9.2)
Yes	25.2 (22.7, 27.8)	28.3 (27.1, 29.4)	25.2 (22.7, 27.8)	26.7 (25.4, 27.9)

Note: Values are % (95% CI). Appropriate survey weights were used in all calculations to account for complex sample design features in each survey.

BRFSS, Behavioral Risk Factor Surveillance System; CKD, chronic kidney disease; CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration Equation; GFR, glomerular filtration rate; MDRD, Modification of Diet in Renal Disease Study Equation; NHANES, National Health and Nutrition Examination Survey.

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Table 2

Estimated U.S. CKD Awareness Using NHANES and BRFSS, by Equation Estimating GFR and Covariate Category

Characteristics	GFR estimate MDRD equation		GFR estimate CKD-EPI equation	
	NHANES 2011–2012 (*n*=5,055)	Imputed BRFSS 2011 (*n*=506,467)	NHANES 2011–2012 (*n*=5,055)	Imputed BRFSS 2011 (*n*=506,467)
Overall	8.5 (5.8, 11.1)	8.6 (7.7, 9.5)	9.1 (6.2, 11.9)	9.0 (8.0, 10.0)
Age, years				
<65	7.8 (4.5, 11.2)	7.9 (6.8, 9.1)	8.8 (5.3, 12.4)	8.5 (7.3, 9.9)
≥65	9.2 (5.2, 13.3)	9.3 (8.5, 10.1)	9.3 (5.1, 13.6)	9.5 (8.7, 10.2)
Race				
Non-Hispanic white	8.1 (4.2, 11.9)	8.4 (7.3, 9.4)	9.0 (4.7, 13.2)	8.8 (7.6, 10.1)
Non-Hispanic black	10.8 (6.3, 15.4)	9.9 (8.5, 11.3)	10.3 (6.2, 14.4)	9.9 (8.6, 11.2)
Hispanic	10.1 (4.1, 16.1)	5.9 (3.7, 8.1)	10.4 (4.3, 16.5)	6.0 (3.5, 8.5)
Others	4.8 (1.2, 8.4)	12.4 (10.5, 14.3)	4.8 (1.1, 8.5)	12.7 (10.7, 14.6)
Sex				
Male	6.0 (3.1, 9.0)	9.6 (8.6, 10.7)	6.3 (3.3, 9.2)	10.0 (8.9, 11.1)
Female	10.3 (6.5, 14.2)	7.9 (6.8, 9.0)	11.4 (7.2, 15.6)	8.3 (7.0, 9.5)
Diabetes				
No	6.6 (4.1, 9.0)	6.3 (5.2, 7.3)	7.2 (4.6, 9.7)	6.5 (5.3, 7.7)
Yes	13.7 (8.9, 18.6)	14.7 (12.9, 16.5)	13.8 (8.9, 18.8)	15.3 (13.2, 17.4)
Hypertension				
No	5.1 (1.8, 8.3)	4.3 (3.3, 5.2)	5.5 (2.0, 9.0)	4.4 (3.3, 5.6)
Yes	11.0 (7.6, 14.5)	11.6 (10.4, 12.7)	11.6 (8.2, 15.1)	12.0 (10.8, 13.3)

Note Values are % (95% CI). Appropriate survey weights were used in all calculations to account for complex sample design features in each survey.

BRFSS, Behavioral Risk Factor Surveillance System; CKD, chronic kidney disease; CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration Equation; GFR, glomerular filtration rate; MDRD, Modification of Diet in Renal Disease Study Equation; NHANES, National Health and Nutrition Examination Survey.

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Table 3

State-Level Self-reported Kidney Disease, CKD Prevalence (Based on CKD-EPI eGFR Formula) and Awareness in U.S.

	Self-reported kidney disease		Imputed CKD prevalence		Estimated CKD awareness	
State	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
IA	1.5	0.2	14.1	0.6	5.8	0.5
NJ	2.0	0.2	14.6	0.3	6.7	0.7
MN	1.7	0.1	13.6	0.5	6.8	0.6
MD	1.9	0.2	14.1	0.4	6.8	0.5
MA	1.9	0.1	14.0	0.4	7.0	0.5
ND	1.9	0.2	14.4	0.8	7.5	0.4
CT	1.9	0.2	14.8	0.8	7.7	0.8
VA	1.9	0.3	14.2	0.7	7.7	1.3
NE	2.2	0.1	14.2	0.5	7.7	0.5
NC	2.2	0.2	14.5	0.6	7.8	0.9
WA	2.3	0.2	13.6	0.6	7.8	0.7
VT	2.2	0.2	14.0	0.6	7.9	0.6
SD	2.0	0.2	15.0	1.0	8.0	1.1
IN	2.1	0.2	14.5	0.5	8.0	0.5
TN	2.1	0.3	14.7	0.9	8.0	1.3
SC	2.2	0.2	15.4	0.6	8.0	0.6
WI	2.1	0.3	13.6	0.7	8.1	1.3
RI	2.3	0.2	14.9	1.0	8.1	0.9

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	Self-reported kidney disease		Imputed CKD prevalence		Estimated CKD awareness	
State	**Estimate**	**SE**	**Estimate**	**SE**	**Estimate**	**SE**
WY	2.2	0.2	13.4	0.8	8.2	1.1
KS	2.3	0.1	14.2	0.3	8.5	0.5
PA	2.5	0.2	15.3	0.5	8.5	0.7
CO	2.2	0.2	12.1	0.6	8.6	0.7
ME	2.4	0.2	14.8	0.4	8.6	0.6
NH	2.4	0.3	13.8	0.5	8.6	1.2
KY	2.5	0.2	14.6	0.6	8.6	1.0
MS	2.4	0.2	15.7	0.6	8.7	0.6
OR	2.4	0.2	14.0	0.6	8.8	0.7
MT	2.5	0.2	14.5	0.8	8.8	0.8
AL	2.7	0.2	15.9	0.7	9.0	0.6
MO	2.3	0.2	15.1	0.5	9.1	0.9
CA	2.4	0.1	14.3	0.4	9.3	0.9
OH	2.5	0.2	14.8	0.6	9.4	0.6
NV	2.5	0.3	14.1	0.6	9.4	1.4
DE	2.5	0.3	15.2	0.7	9.4	1.3
LA	2.6	0.2	15.4	0.5	9.4	0.7
NY	2.9	0.3	14.7	0.8	9.4	0.9
AK	2.3	0.3	11.3	1.0	9.5	2.0
ID	2.4	0.2	13.4	0.6	9.5	0.8

State	Self-reported kidney disease		Imputed CKD prevalence		Estimated CKD awareness	
	Estimate	SE	Estimate	SE	Estimate	SE
IL	2.8	0.4	14.6	0.6	9.8	1.4
FL	3.2	0.2	16.8	0.5	9.9	0.9
TX	2.6	0.2	13.4	0.5	10.0	1.1
AR	3.0	0.4	15.4	0.7	10.0	1.1
MI	3.0	0.2	14.8	0.5	10.2	0.9
OK	3.1	0.2	15.0	0.5	10.2	0.8
UT	2.8	0.2	11.6	0.2	10.6	0.7
WV	2.8	0.2	15.6	0.8	10.6	1.1
DC	2.7	0.3	14.4	0.7	11.1	1.2
GA	2.8	0.2	14.1	0.4	11.1	0.9
NM	3.0	0.2	14.2	0.5	11.2	1.2
AZ	3.5	0.4	14.3	0.6	11.7	1.0

Note: All values are percentages. Estimates based on 2011 BRFSS data with; appropriate survey weights were used in all calculations to account for complex sample design features in each survey.

BRFSS, Behavioral Risk Factor Surveillance System; CKD, chronic kidney disease; CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration Equation; eGFR, estimated glomerular filtration rate; MDRD, Modification of Diet in Renal Disease Study Equation; NHANES, National Health and Nutrition Examination Survey.

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