Chapter 1: CKD in the General Population

- Almost half of individuals with CKD also have diabetes and/or self-reported CVD.
- Overall prevalence of CKD in the general population is approximately 14%, which closely mirrors the prevalence of individuals in the high-risk KDIGO prognosis categories.
- Approximately 20% of individuals have measured ACR between 10-29 mg/g, which although below the threshold for diagnosing albuminuria, indicates some protein in the urine.
- Age is the greatest predictor of low eGFR (eGFR < 60 ml/min/1.73m^2), while hypertension is the greatest predictor of albuminuria (ACR > 30 mg/g).
- Comparing three cohorts of NHANES participants (1988-1994, 1999-2004, and 2007-2012) improvements have occurred in the percent of individuals at target blood pressures, percent of individuals not smoking, and percentage of diabetics with glycosylated hemoglobin <7%.
- Within the same cohorts, little improvement has been seen in the percent of individuals with CKD being aware of their disease, especially in stages 1 to 3. A small improvement in disease awareness has been seen in those with Stage 4 CKD.
- Self-reported CKD is very low in the U.S. general population, ranging from 1.8 % in Virginia to 4.0% in Arizona.

Introduction

This chapter presents representative cross-sectional estimates of chronic kidney disease (CKD) prevalence in the United States (U.S.), analyzing data from the National Health and Nutrition Examination Survey (NHANES; CDC 2015a). Administered by the Centers for Disease Control and Prevention (CDC), the NHANES program of studies combines interviews and physical examinations, creating a valuable source of information for assessing disease prevalence and at-risk groups in the general U.S. population. NHANES data are released biennially; we primarily report trends based on three 6-year time periods within the last 24 years—1988–1994, 1999-2004 and 2007-2012. NHANES data collection was not conducted during 1995-1998.

Utilizing a data source new to the ADR, the Behavioral Risk Factors Surveillance System (BRFSS; CDC 2015b), this year we also present the 2012 prevalence of self-reported kidney disease by geographic region. Also administered by the CDC, the BRFSS is a system of health-related telephone surveys that collect state-level data of U.S. residents regarding their health-related risk behaviors, chronic health conditions, and use of preventive services. Similar to the NHANES survey, weights are applied to allow generation of estimates that are representative of the U.S. population. In the survey, each participant is asked a simple question pertaining to kidney disease "(Ever told) you have kidney disease?" With the availability of participants' residence, we can begin to assess geographic distributions of self-reported kidney disease in a representative sample of U.S. residents.

The biochemical data available in NHANES are used to evaluate kidney function through estimating glomerular filtration rate (eGFR), and kidney damage through urinary albumin excretion. Consistent with the prevalence assessment of other diseases included in this national survey, both parameters are measured at a single point in time. In clinical practice, diagnosis of CKD typically requires multiple assessments of kidney function and urine protein over weeks or months. Due to the fact that repeated measures of kidney function are limited to a voluntary subset of the 1988–1994 NHANES participants, we must rely on a single, cross-sectional sample available on the full

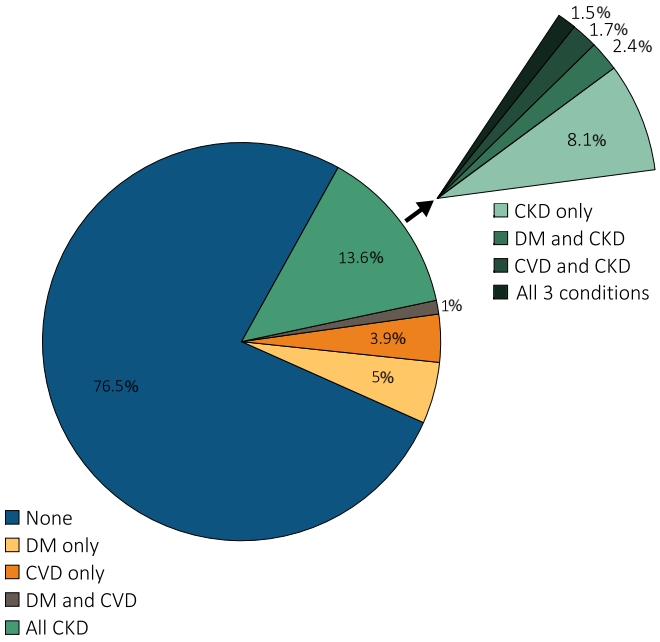
samples in all three cohorts to estimate the prevalence of CKD in the U.S. adult population, and to determine CKD trends over time. Thus, the estimates of CKD reported in this chapter will be higher than would be the case if measures of eGFR and urine albumin/creatinine ratio (ACR) were repeated over time to fulfill the 'persistence for 3 months or longer' criteria for the clinical diagnosis of CKD.

As the NHANES database does not contain diagnostic information, we developed criteria underlying the definition of CKD based upon the KDIGO 2012 Clinical Practice Guideline for the Evaluation and Management of Chronic Kidney Disease (KDIGO, 2012). First, we evaluate kidney function by eGFR as calculated using the CKD-EPI creatinine equation (Levey et al., 2009). Individuals with eGFR <60 ml/min/1.73m² are considered to have reduced kidney function. Secondly, we use the ACR to assess urinary albumin excretion, and consider four categories of measurements: <10 mg/g, 10-<30 mg/g (normal to slightly elevated values), 30-300 mg/g (microalbuminuria), and >300 mg/g (macroalbuminuria). Lastly, we consider a composite measure of both eGFR and ACR, classifying individuals as CKD if they have either an eGFR <60 ml/min/1.73m² or ACR ≥30 mg/g. Staging of kidney disease follows the Kidney Disease Outcomes and Quality Improvement (KDOQI) CKD guidelines (NKF, 2002). In contrast, other chapters in this ADR volume identify the presence of CKD and its related stages based on ICD-9-CM (International Classification of Diseases, 9th revision, clinical modification) diagnosis codes.

This chapter begins with an examination of the prevalence of CKD in the U.S. among individuals aged 20 or older. We also evaluate the population distributions of eGFR and ACR over time, and the KDIGO prognostic categories based on cross-tabulations of these two measures in the 2007-2012 NHANES samples. Next, we assess the burden of CKD among individuals with interrelated conditions of public health relevance—diabetes mellitus (DM), hypertension (HTN), self-reported cardiovascular disease (SR CVD), and obesity.

Figure 1.1 displays the importance of CKD as a non-communicable chronic disease; large proportions of individuals with kidney disease also suffer from DM, SR CVD, or have all three conditions.

vol 1 Figure 1.1 Distribution of NHANES participants with diabetes, self-reported cardiovascular disease, & single-sample markers of CKD, 2007-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Note: Cardiovascular disease designation is based on self-report of any CVD condition (see CKD Analytical Methods chapter for detail); CKD is defined as eGFR <60 or ACR ≥30. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; SR CVD, self-reported cardiovascular disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate.

Through exploration of the implications of kidney function and the related comorbidities of DM, HTN, and SR CVD in the general population, this chapter sets the stage for Chapter 2 (Vol. 1, Identification and Care of Patients with CKD). There we discuss CKD as recognized in the health care system via analysis of Medicare claims data, providing extensive information on morbidity, interventions, and costs.

We conclude the chapter by examining participant awareness of CKD and hypertension, treatment of CKD and comorbidities, and control of major CKD risk factors. We also illustrate the burden of hypertension, total cholesterol, elevated uric acid, smoking, and glycemic control within populations of individuals with eGFR <60 or ACR ≥30. It will be important to determine whether changes in the awareness, treatment, and control of major risk factors translate into reduced rates of cardiovascular events, death, and progression of CKD to end-stage renal disease.

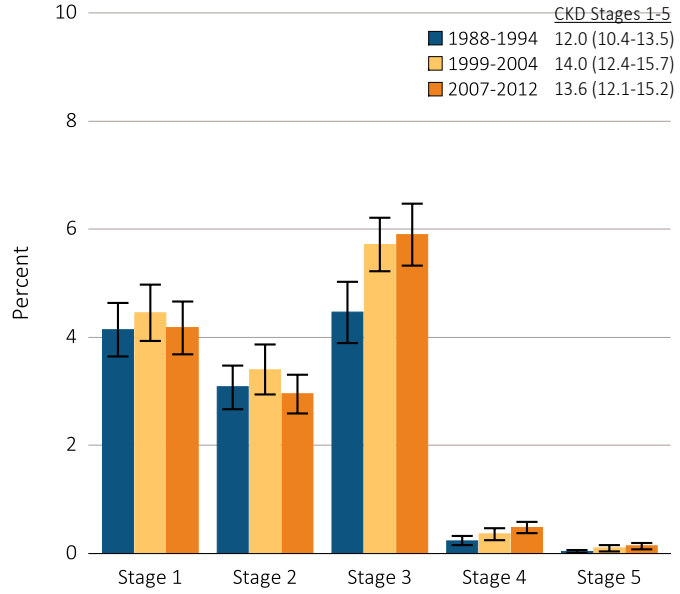
Analytical Methods

See the CKD Analytical Methods chapter for an explanation of analytical methods used to generate the figures and tables in this chapter.

Prevalence of CKD

The overall prevalence of CKD in the U.S. increased from 1988-1994 to 1999-2004 (12% to 14%), but has since remained stable (2007-2012). Figure 1.2 shows that the largest increase occurred in Stage 3 CKD, which rose from 4.5% to 6.0% over the three time periods. Percent of individuals in stages 1 and 2 increased from 1988-1994 to 1999-2004, but then reverted to initial levels in the most recent time frame.

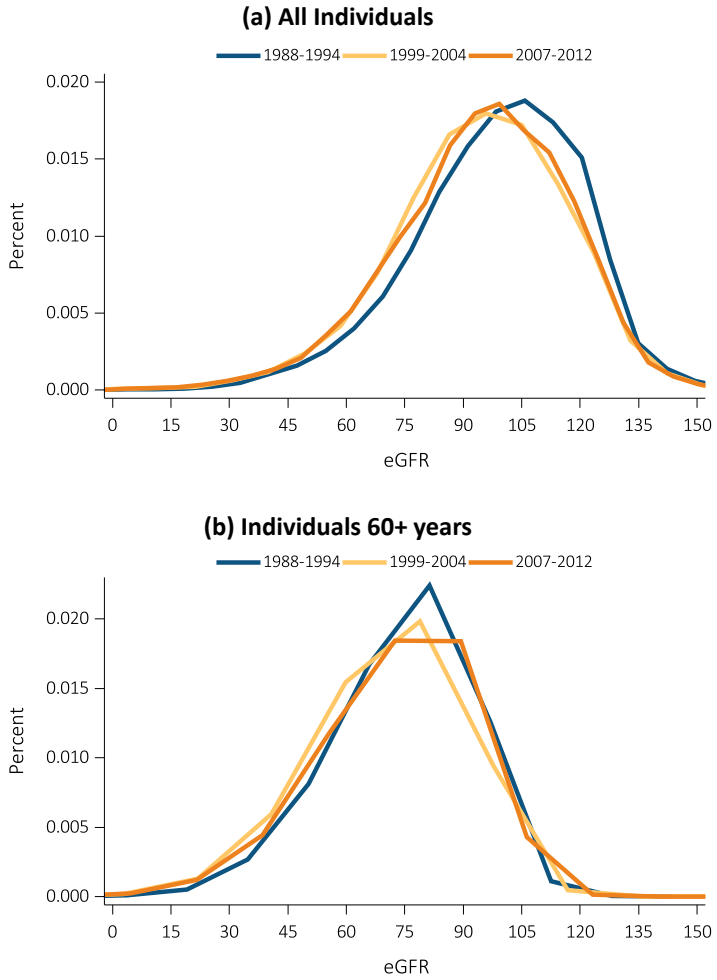
vol 1 Figure 1.2 Prevalence of CKD by stage among NHANES participants, 1988-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Whisker lines indicate 95% confidence intervals. Abbreviations: CKD, chronic kidney disease.

Figure 1.3 illustrates density distributions of eGFR in 1988–1994, 1999-2004 and 2007-2012. Overall, a population shift towards lower eGFR levels was observed as compared with the 1988-1994 period, with most of the leftward shift confined to eGFR levels between 50 and 130 ml/min/1.73 m². To explore whether the change could be attributed to an aging U.S. population, the distribution was also examined among individuals over the age of 60 years. Within the older population there has been less change in the distribution over the three time periods examined.

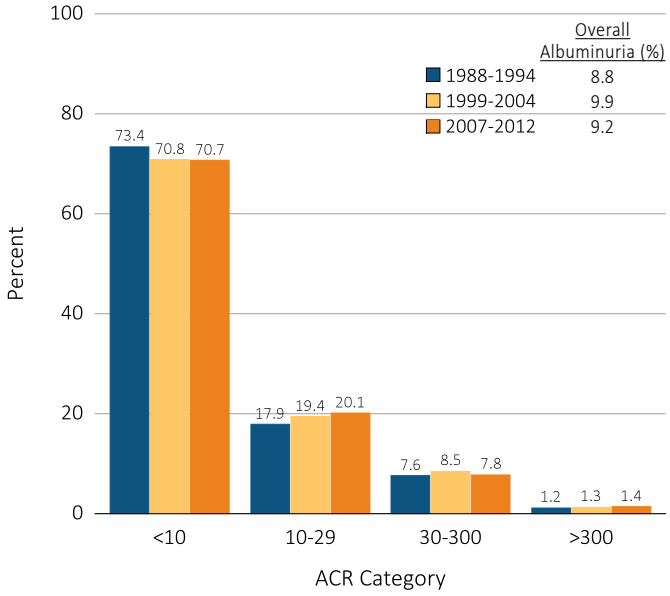
vol 1 Figure 1.3 eGFR distribution among NHANES participants, 1988-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR; eGFR calculated using the CKD-EPI equation. Abbreviations: eGFR, estimated glomerular filtration rate. Accounts for change in serum creatinine assays.

Figure 1.4, with corresponding findings for ACR, shows little change in the distribution patterns of individuals with microalbuminuria or macroalbuminuria. However, examination of the group with ACR < 30 mg/g, shows a decrease in the proportion of individuals with ACR < 10 and, an increase in the proportion of individuals with ACR 10 to <30 mg/g, over the three eras.

vol 1 Figure 1.4 Urine albumin/creatinine ratio distribution among NHANES participants, 1988-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of ACR. Abbreviations: ACR, urine albumin/creatinine ratio.

When assessing the inter-relationship of eGFR and ACR, we saw increased prevalence of albuminuria with decreases in kidney function. For example, in the 2007 to 2012 NHANES sample, 6.5% of persons with normal kidney function (>90 eGFR ml/min/1.73m²) had some evidence of albuminuria. This increased to 9.4% among individuals with an eGFR of 60-90, 22.2% for those with an eGFR of 45-59, and 46.7% for those with an eGFR of 30-44. For persons with Stage 4 CKD (eGFR <30 ml/min/1.73m²), over half have evidence of micro- or macroalbuminuria. Details of this cross-tabulation can be viewed in Table 1.2 of the 2014 ADR. Over the three time periods there was a rise in the percent of individuals in the three higher-risk KDIGO categories, increasing from 12% of 1988-1994 participants to approximately 14 % in both 1999-2004 and 2007-2012 (see Table 1.1).

Comorbidity, Risk Factors, Treatment, and Control

Many studies have shown that older age, diabetes, hypertension, cardiovascular disease and higher body mass index (≥30 kg/m²; BMI) are associated with CKD. Data showing the percentage of adult NHANES participants with either a spot eGFR <60 ml/min/1.73m² or a spot ACR ≥30 mg/g confirms higher estimated prevalence in the presence of each of these risk factors (Table 1.2).

vol 1 Table 1.1 Prognosis of CKD by KDIGO 2012 eGFR and albuminuria categories, percentage of NHANES participants, 1988-2012

	NHANES 1988-1994	NHANES 1999-2004	NHANES 2007-2012
Low risk	88.0	85.9	86.2
Moderately high risk	9.0	10.5	9.8
High risk	12.0 — 2.1	14.1 — 2.3	13.8 — 2.3
Very high risk	0.9	1.3	1.7

Data source: National Health and Nutrition Examination Survey (NHANES), 1988-1994, 1999-2004 & 2007-2012 participants aged 20 and older. Single-sample estimates of eGFR and ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; GFR, glomerular filtration rate; KDIGO, Kidney Disease: Improving Global Outcomes CKD Work Group. Low risk: eGFR ≥ 60 ml/min/1.73 m² and ACR <30 mg/g; moderately high risk: eGFR 45-59 ml/min/1.73m² or eGFR ≥60 ml/min/1.73 m² and ACR 30-300 mg/g; high risk: eGFR 30-44 ml/min/1.73m² or eGFR 45-59 ml/min/1.73m² and ACR 30-300 mg/g or eGFR ≥60 ml/min/1.73m² and ACR >300 mg/g; very high risk: eGFR <30 ml/min/1.73m² or eGFR 30-44 ml/min/1.73m² and ACR 30-300 mg/g or eGFR ≥60 ml/min/1.73m² and ACR >300 mg/g.

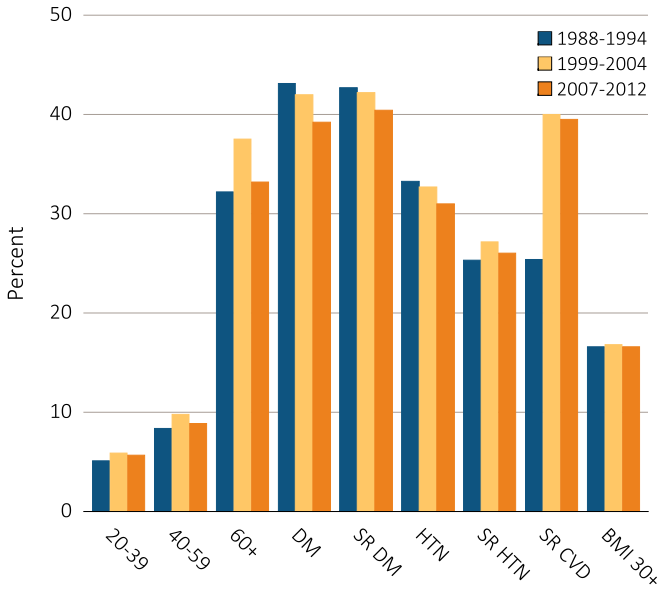
vol 1 **Table 1.2 Prevalence (%) of CKD in NHANES population within age, sex, race/ethnicity, & risk-factor categories, 1988-2012**

	All CKD			eGFR <60ml/min/1.73m²			ACR ≥30 mg/g		
	1988-1994	1999-2004	2007-2012	1988-1994	1999-2004	2007-2012	1988-1994	1999-2004	2007-2012
Age									
20-39	5.1	5.9	5.7	0.1	0.3	0.2	5.0	5.8	5.5
40-59	8.4	9.8	8.9	1.3	2.0	2.3	7.5	8.4	7.2
60+	32.2	37.5	33.2	19.1	25.1	22.7	18.0	20.1	17.7
Sex									
Male	10.2	12.3	12.1	4.1	5.0	5.4	7.4	9.2	8.7
Female	14.2	15.7	15.1	5.6	7.2	7.6	10.2	10.3	9.6
Race/Ethnicity									
Non-Hispanic White	12.3	14.0	13.9	5.5	7.0	7.6	8.2	8.9	8.4
Non-Hispanic Black/African American	14.5	14.9	15.9	4.1	5.0	6.2	12.7	12.4	12.3
Mexican American	11.8	11.2	12.0	5.0	1.5	2.2	8.2	10.5	10.8
Other Hispanic	14.1	13.6	11.8	3.8	3.9	4.0	12.1	11.5	9.8
Other Non-Hispanic	11.2	15.0	11.5	2.9	4.6	3.7	9.7	12.6	9.7
Risk Factor									
Diabetes	43.1	42.0	39.2	15.6	17.0	19.6	36.3	33.3	28.6
Self-reported diabetes	42.7	42.2	40.4	16.4	18.5	21.1	35.9	32.6	29.3
Hypertension	33.3	32.7	31.0	15.3	17.1	17.1	23.4	21.3	19.8
Self-reported hypertension	25.3	27.2	26.0	12.9	15.8	15.2	17.1	16.4	16.2
Self-reported cardiovascular disease	25.4	40.0	39.5	14.5	27.3	26.8	16.6	23.0	23.8
Obesity (BMI >30)	16.6	16.8	16.6	6.2	6.4	7.3	12.3	12.6	11.5
All	12.0	14.0	13.6	4.9	6.2	6.5	8.8	9.8	9.2

Data source: National Health and Nutrition Examination Survey (NHANES), 1988-1994, 1999-2004 & 2007-2012 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Diabetes defined as either HbA1c >7%, self-reported (SR), or currently taking glucose-lowering medications. Hypertension defined as BP ≥130/≥80 for those with diabetes or CKD, otherwise BP ≥140/≥90, or taking medication for hypertension. Values in Figure 1.12 cannot be directly compared to those in Table 1.2 due to different Survey cohorts. The table represents NHANES participants who are classified as hypertensive (measured/treated) but some of those are at target blood pressure. Abbreviations: ACR, urine albumin/creatinine ratio; BMI, body mass index; BP, blood pressure, CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate; HbA1c, glycosylated hemoglobin.

Occurrences of eGFR less than 60 ml/min/1.73m² and ACR ≥30 mg/g for adult NHANES participants are shown in Table 1.2. When CKD is defined by either eGFR <60 or ACR ≥30, prevalence estimates over time rose from 12.0 to 14.0%, and then decreased to 13.6% (Figure 1.5). The largest relative increase in prevalence (1.6-fold) was seen among those with SR CVD, where estimates rose from 25.4% in 1988-1994 to 40.0% in 1999-2004 and 39.5% in 2007-2012. The prevalence of eGFR <60 rose from 4.9 to 6.2% and then to 6.5% over the three periods, with the largest relative increase (1.5-fold) in those aged 40–59 (from 1988-1994 to 1999-2004). Prevalence for ACR ≥30 first rose from 8.8 to 9.8%, then declined to 9.2% across the three periods; this increased from 16.6 to 23.0%, and then to 23.8% for those with SR CVD.

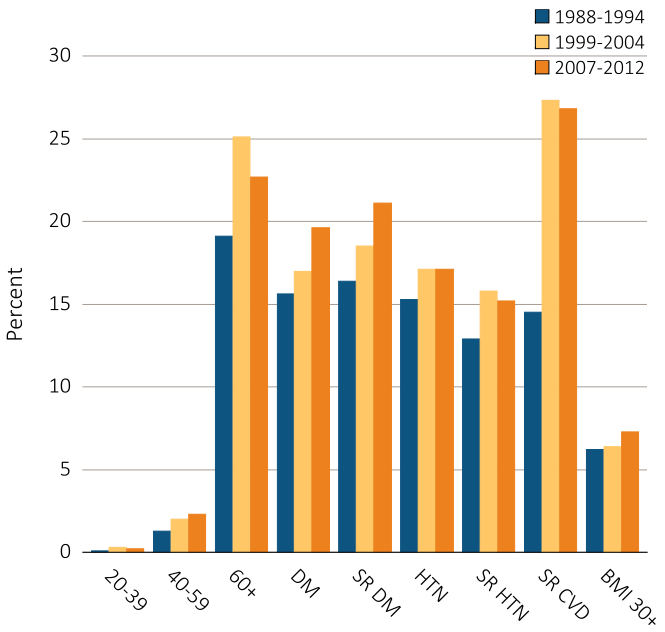
vol 1 **Figure 1.5 Prevalence of CKD by age & risk factor among NHANES participants, 1988-2012**



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Diabetes defined as either HbA1c >7%, self-reported, or currently taking glucose-lowering medications. Hypertension defined as BP ≥130/≥80 for those with diabetes or CKD, otherwise BP ≥140/≥90, or taking medication for hypertension. Abbreviations: BMI, body mass index; CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; HbA1c, glycosylated hemoglobin; HTN, hypertension; SR, self-reported.

Figure 1.6 shows that CKD defined by eGFR <60 was much more prevalent in individuals aged 60 and older. Low eGFR was present for up to 25.0% of the cohort of 1999-2004 participants, compared to 0.3% of individuals aged 20 to 39 years and 2.0% of those aged 40 to 59 years. The prevalence of low eGFR also rose in all other comorbidity categories after the years 1988-1994, especially for SR CVD. Although some of the divergence in prevalence estimates for markers of SR CKD may result from a change in data collection methods and categorization after the 1988-1994 cohort, these substantial differences have yet to be adequately explained.

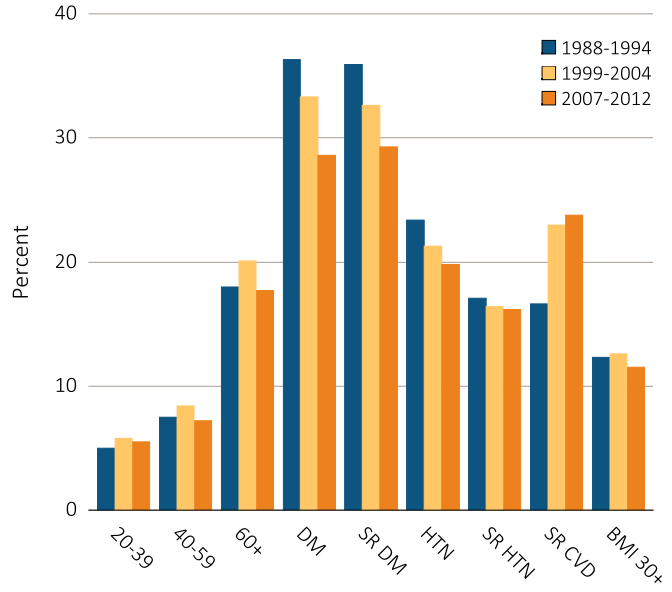
vol 1 **Figure 1.6 NHANES participants with eGFR <60 ml/min/1.73m², by age & risk factor, 1988-2012**



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR; eGFR calculated using the CKD-EPI equation. Diabetes defined as either HbA1c >7%, self-reported (SR), or currently taking glucose-lowering medications. Hypertension defined as BP ≥130/≥80 for those with diabetes or CKD, otherwise BP ≥140/≥90, or taking medication for hypertension. Abbreviations: BMI, body mass index; CVD, cardiovascular disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HbA1c, glycosylated hemoglobin; HTN, hypertension; SR, self-reported.

The prevalence of ACR ≥30 mg/g has decreased over the three time periods among individuals with DM, self-reported DM, HTN, self-reported HTN, and higher BMI (Figure 1.7). Prevalence also increased in the older age groups, but less markedly than for eGFR <60.

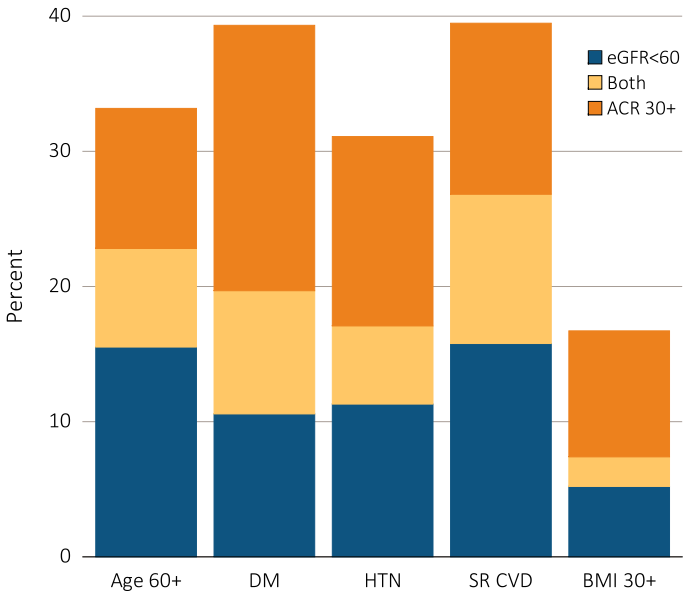
vol 1 Figure 1.7 NHANES participants with urine albumin/creatinine ratio ≥30 mg/g, by age & risk factor, 1988-2012



Data source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of ACR. Diabetes defined as either HbA1c >7%, self-reported (SR), or currently taking glucose-lowering medications. Hypertension defined as BP ≥130/≥80 for those with diabetes or CKD, otherwise BP ≥140/≥90, or taking medication for hypertension. Abbreviations: BMI, body mass index; CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; HbA1c, glycosylated hemoglobin; HTN, hypertension; SR, self-report.

Figure 1.8 displays the prevalence of CKD markers (eGFR <60 ml/min/1.73m² and ACR ≥30 mg/g) among adult NHANES 2007–2012 participants aged 60 years and older, and those with comorbid conditions of diabetes, hypertension, SR CVD, and higher BMI. The prevalence of eGFR <60 was highest among those aged 60 years or older (22.8%) and those with SR CVD (26.8%), followed by those with DM , HTN, and higher BMI, at 20.3, 17.2 and 7.4%, respectively. An ACR ≥30 was most common in those with diabetes, at 29.3%, followed by those with SR CVD, aged 60 or older, with HTN, and higher BMI, at 19.8, 17.7, 13.7, and 11.5%, respectively. The presence of both eGFR <60 and ACR ≥30 was most common with SR CVD, at 15.8%, followed by DM, those aged 60 years and older, HTN, and higher BMI, at 9.7, 7.3, 5.8, and 2.2%, respectively.

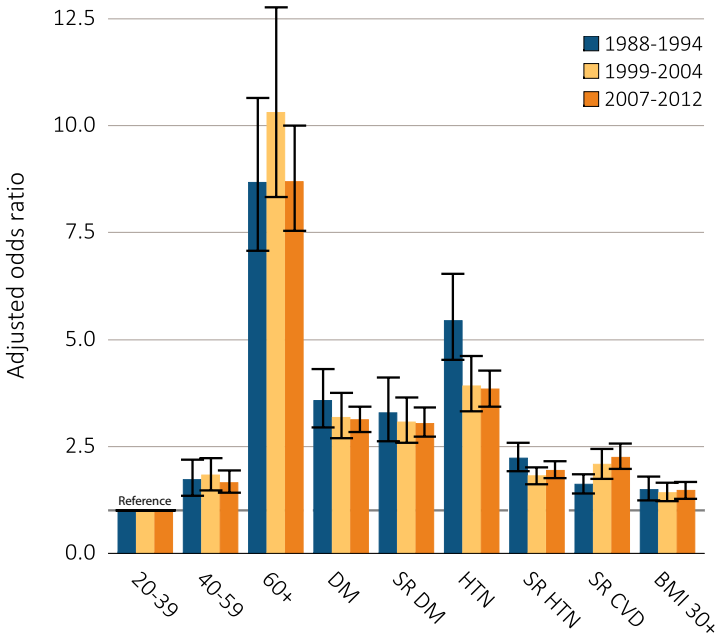
vol 1 Figure 1.8 Distribution of markers of CKD in NHANES participants with diabetes, hypertension, self-reported cardiovascular disease, & obesity, 2007–2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; BMI, body mass index; CKD, chronic kidney disease; DM, diabetes mellitus; SR CVD, self-reported cardiovascular disease; eGFR, estimated glomerular filtration rate; HTN, hypertension.

Figures 1.9-1.11 show the greater odds ratios for presence of eGFR <60 ml/min/1.73m², ACR ≥30 mg/g, and either eGFR <60 or ACR ≥30 for each of the comorbid conditions, once adjusted for age, sex, and race.

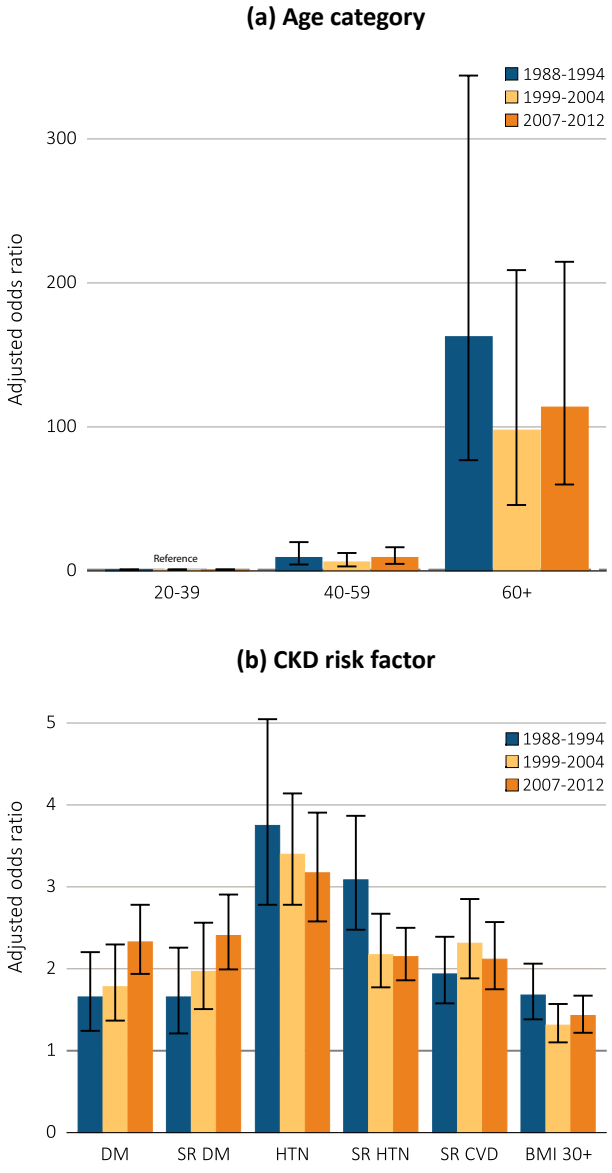
vol 1 Figure 1.9 Adjusted odds ratios of CKD in NHANES participants by risk factor, 1988-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. CKD defined as presence of eGFR <60 ml/min/1.73m², ACR ≥ 30 mg/g, and either eGFR <60 or ACR ≥30 for each of the comorbid conditions. Adjusted for age, sex, & race; single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Whisker lines indicate 95% confidence intervals. Abbreviations: ACR, urine albumin/creatinine ratio; BMI, body mass index; CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HTN, hypertension; SR, self-report.

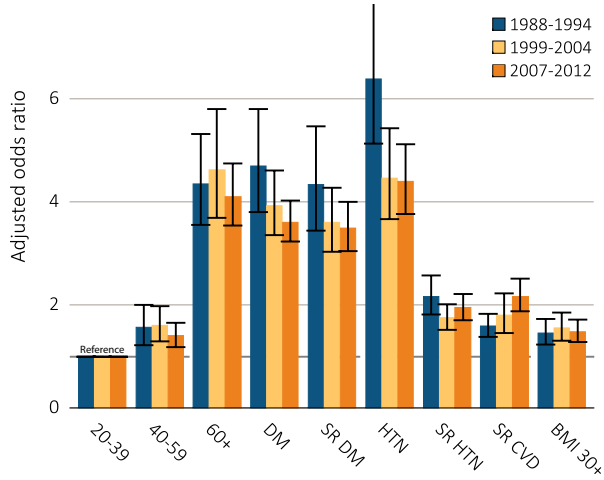
Adjusted odds ratios for eGFR <60 ml/min/1.73m² or ACR ≥30 mg/g (Figure 1.9) were lower in NHANES 1999-2004 and 2007–2012 participants than in 1988–1994 for each risk factor except SR CVD, where adjusted odds ratios rose from 1.61 to 2.25. For eGFR <60 alone (Figure 1.10), adjusted odds ratios followed a similar pattern, except for diabetes and self-reported diabetes, where the odds increased from 1.66 to approximately 2.35 in both groups. Also, eGFR <60 showed a very strong association with age, with adjusted odds ratios in the 100 range. For ACR ≥30 alone (Figure 1.11), a substantial decline in the adjusted odds ratio is seen among those for both diabetes (from 4.70 to 3.60) and hypertension (from 6.37 to 4.40), while a substantial increase in the adjusted odds ratio is seen for SR CVD (from 1.59 to 2.17).

vol 1 Figure 1.10 Adjusted odds ratios of eGFR <60 ml/min/1.73m2 in NHANES participants by age & risk factor, 1988-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older; single-sample estimates of eGFR. Adjusted for age, sex, & race; eGFR calculated using the CKD-EPI equation. Whisker lines indicate 95% confidence intervals. Abbreviations: BMI, body mass index; CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HTN, hypertension; SR, self-report.

vol 1 **Figure 1.11 Adjusted odds ratios of urine albumin/creatinine ratio ≥30 mg/g in NHANES participants by age & risk factor, 1988-2012**



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older; single-sample estimates of ACR. Adjusted for age, sex, & race. Whisker lines indicate 95% confidence intervals. Abbreviations: ACR, urine albumin/creatinine ratio; BMI, body mass index; CKD, chronic kidney disease; CVD, cardiovascular disease; DM, diabetes mellitus; HTN, hypertension; SR, self-report.

Treatment of CKD

Table 1.3 presents awareness of hypertension, treatment of CKD contributing conditions, and control of hypertension, hyperlipidemia, and diabetes in NHANES 1988–1994, 1999–2004 and 2007–2012 adult participants with eGFR <60 ml/min/1.73m² or ACR ≥30 mg/g. While the prevalence of hypertension among CKD patients was similar in the three periods, ranging from 69.3 to 74.0%, the proportion of participants unaware of their hypertension rose from 33.4% to 50.6% in the first two survey time frames and then declined to 22.5% by the third survey period.

vol 1 **Table 1.3 Awareness, treatment, & measures of control of CKD risk factors, percent of NHANES participants, 1988-2012**

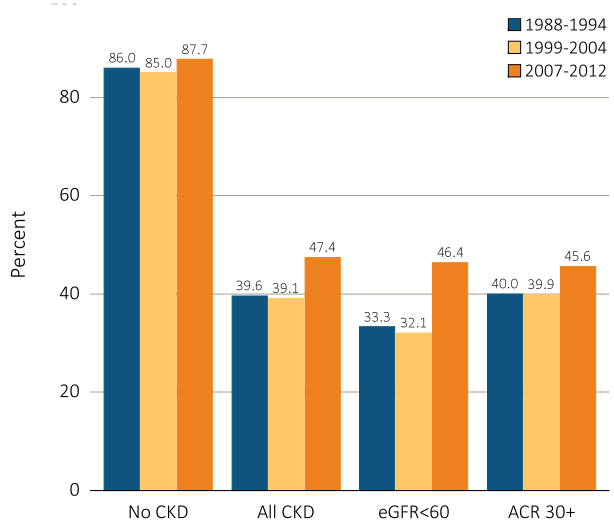
	All CKD				eGFR <60 ml/min/1.73m2				ACR ≥30			
	1988-1994	1999-2004	2007-2012	Trend p-value	1988-1994	1999-2004	2007-2012	Trend p-value	1988-1994	1999-2004	2007-2012	Trend p-value
Hypertension, by current hypertensive status[a]												
Non-hypertensive status	30.7	26.5	26.0		18.4	14.3	15.9		32.0	30.4	29.1	
Hypertensive (measured/ treated)	69.3	73.5	74.0	**0.01**	81.6	85.7	84.1	0.29	68.0	69.6	70.9	0.07
Control of hypertension among hypertensive patients[b]												
Unaware	33.4	50.6	22.5		22.8	44.2	16.4		36.0	54.7	25.1	
Aware, not treated	14.7	6.3	6.5		12.1	4.2	2.8		15.7	7.1	8.7	
Aware, treated, uncontrolled	39.2	31.5	43.9	**<0.001**	47.8	36.4	46.6	**<0.001**	38.4	30.2	44.8	**<0.001**
Aware, treated, controlled	12.7	11.5	27.2		17.3	15.2	34.2		9.9	8.0	21.4	
Total cholesterol[c]												
<200 (desirable)	35.1	46.6	58.7		27.2	45.6	62.1		38.2	47.5	58.2	
200–239 (borderline high)	33.5	32.6	26.4	**<0.001**	32.7	33.7	23.5	**<0.001**	32.8	31.9	27.3	**<0.001**
240+ (high)	31.4	20.8	14.9		40.0	20.7	13.4		29.0	20.6	14.5	
Uric Acid												
Normal	69.6	69.2	69.2	0.84	54.4	55.2	55.1	0.84	73.9	74.0	75.4	0.45
High	30.4	30.8	30.8		45.6	44.8	44.9		26.1	26.0	24.6	
Smoking												
Current	22.2	16.9	14.6		11.9	7.8	8.2		0.03	21.3	17.6	
Former	35.2	32.3	32.6	**<0.001**	43.2	39.4	40.1	**0.03**	31.5	29.1	29.7	**<0.001**
Never	42.6	50.7	52.8		44.9	52.8	51.6		41.5	49.6	52.6	
Control of diabetes among patients with diabetes[d]												
Glycohemoglobin <7% (controlled)	31.5	39.2	45.3		37.1	50.9	55.0		29.6	33.6	37.9	
Glycohemoglobin 7% or higher (uncontrolled)	68.5	60.8	55.7	**<0.001**		49.1	45.0	**0.003**		66.4	62.1	**0.04**

Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of all biologic markers; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate. a. Hypertension defined as blood pressure ≥130/≥80 for those with CKD and diabetes, otherwise ≥140/≥90, or self- reported treatment for hypertension. b. Awareness and treatment are self-reported. Control defined as <130/<80 for those with CKD and diabetes; otherwise <140/<90. c. Total cholesterol classified according to Adult Treatment Panel III blood cholesterol guidelines (ATP III). d. Glycosylated hemoglobin classified according to American Diabetes Association guidelines. Trend tests for control of hypertension compares unaware to the three aware categories, total cholesterol tests <200 vs. 200+, smoking tests any current or past smoking vs. never.

The proportion of hypertensive individuals who were aware, treated, and disease-controlled rose steadily from approximately 12% in the early cohorts to 27.2% in 2007-2012. In the subgroup with diabetes, glycemic control improved firmly from 31.5 to 39.2, and then to 45.3% over the three survey periods.

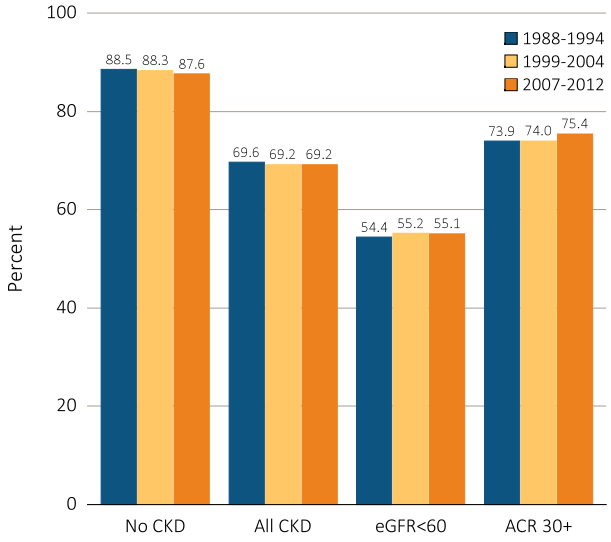
As illustrated by Figures 1.12-1.15, over the periods of 1988–1994, 1999–2004 and 2007–2012, improvements in the management of hypertension, smoking, and hyperglycemia among diabetic participants occurred, regardless of whether eGFR or ACR was used for subgroup definition.

vol 1 Figure 1.12 NHANES participants at target blood pressure, 1988-2012



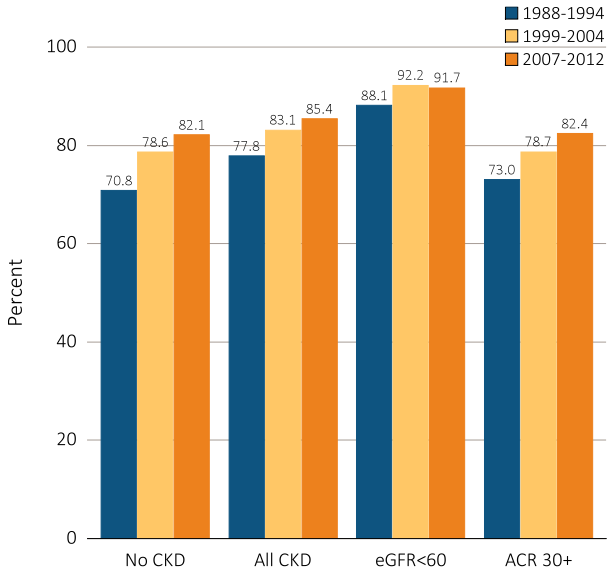
Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Figure represents all hypertensive participants including those who were at target blood pressure, probably due to medication. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

vol 1 Figure 1.13 NHANES participants within uric acid normal range, 1988-2012



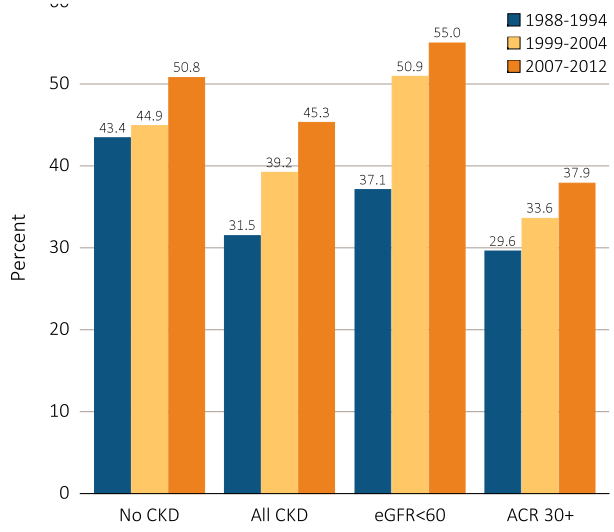
Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

vol 1 Figure 1.14 NHANES participants not currently smoking, 1988-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

vol 1 Figure 1.15 Diabetic NHANES participants with glycosylated hemoglobin <7%, 1988-2012

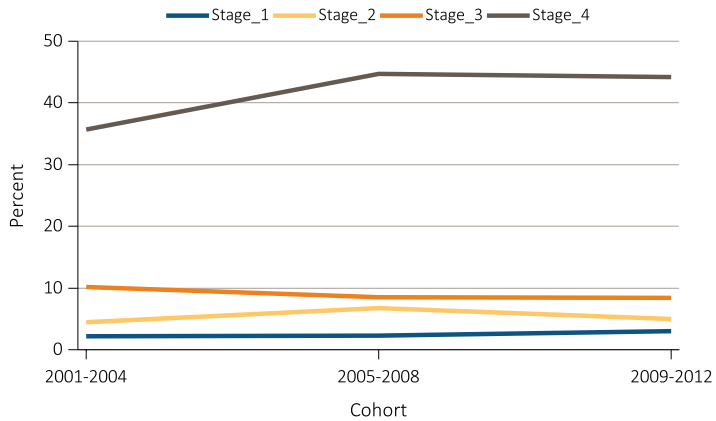


Data Source: National Health and Nutrition Examination Survey (NHANES), 1988–1994, 1999-2004 & 2007–2012 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

CKD Awareness

Among the individuals that are classified as having CKD by laboratory measurements, the percent of those individuals being aware of their kidney disease has remained low over the years 2001-2012 (Figure 1.16). There is some suggestion of an improvement among individuals with Stage 4 CKD between the years 2001-2004 and 2005-2008, although this did not persist in the 2009-2012 cohort. Note that 4-year cohorts are examined in this graphic and the awareness variable was not included in the in the years 1988-1994 sampling of NHANES. Awareness is not presented for Stage 5 CKD due to very small sample size.

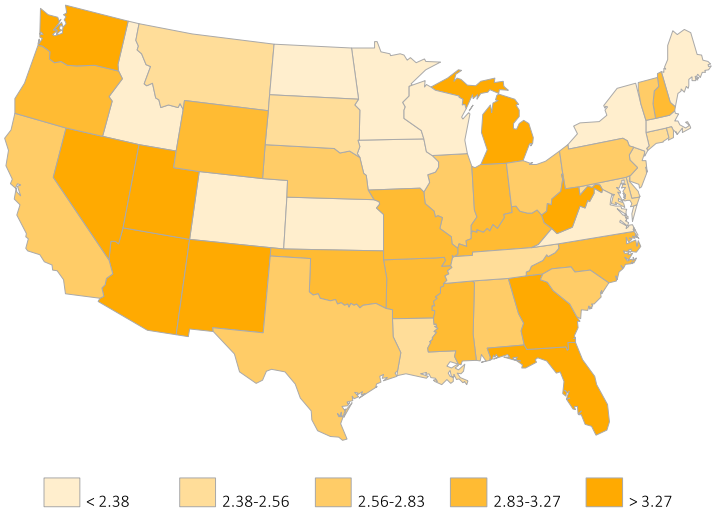
vol 1 Figure 1.16 NHANES participants with CKD aware of their kidney disease, 2001-2012



Data Source: National Health and Nutrition Examination Survey (NHANES), 2001-2012 participants aged 20 & older. Abbreviations: CKD, chronic kidney disease.

Figure 1.17 displays the state-specific proportion of individuals who reported being told they had 'kidney disease' based on the 2012 BRFSS sample. The overall national mean was very low at 2.8%. Also at 2.8%, the prevalence of self-reported kidney disease ('weak or failing kidneys') in NHANES matches this national estimate from the BRFSS survey, suggesting poor identification or awareness of kidney disease in the general population. States with the highest proportion of participants who indicate that they have been informed that they had kidney disease include: Arizona, Florida, West Virginia, Georgia, Hawaii, New Mexico, Michigan, and Washington. Conversely, the states with the lowest proportion reporting kidney disease include: Virginia, Massachusetts, Wisconsin, New York, Colorado, Iowa, Indiana and North Dakota. These differences could reflect varying prevalence of kidney disease by state, or variations in survey participants' awareness of the condition, if present. Underlying prevalence of kidney disease by individual U.S. state is unknown; therefore it is presently unclear whether higher prevalence of 'self-reported kidney disease' reflects higher actual prevalence of the disease, greater awareness among those that have the condition, or a combination of both.

vol 1 Figure 1.17 Estimated prevalence of self-reported kidney disease by state (%), BRFSS participants, 2012 (N = 464,494).



Data source: Behavioral Risk Factors Surveillance System (BRFSS), 2012 participants aged 20 & older.

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