Chapter 1: CKD in the General Population

- Overall prevalence of CKD (Stages 1-5) in the U.S. adult general population was 14.8% in 2011-2014. CKD Stage 3 is the most prevalent (NHANES: Figure 1.2 and Table 1.2).
- Roughly 40% of individuals with CKD also have diabetes, 32% have hypertension, and 40% have self-reported cardiovascular disease (Table 1.2).
- The prevalence of urinary ACR >10 in the general U.S. population is 32%, including 8.5% with ACR 30–300 mg/g and 1.4% with ACR >300 mg/g (Figure 1.4).
- Approximately 20% of individuals have urinary ACR 10-29 mg/g, which although below the threshold for albuminuria, has been shown to have prognostic significance (Figure 1.4).
- Age is best correlate of low eGFR (eGFR <60 ml/min/1.73m^2), while hypertension is the greatest predictor of albuminuria (Figures 1.10 & 1.11).
- In a comparison of four cohorts of NHANES participants (1999-2002, 2003-2006, 2007-2010, and 2011-2014), increases over time were seen in the percentage of individuals at target blood pressure of <140/90 (Figure 1.12) and percentage with normal cholesterol levels (Figure 1.13).
- Minimal change over time was seen in the amount of self-reported physical activity (Figure 1.14).
- Following a 1999-2002 initial increase in the percentage of diabetics with glycosylated hemoglobin <7%, these fell steadily over the last three time periods (Figure 1.15 & Table 1.3).
- Comparing these same NHANES cohorts, little improvement has been seen in the percentage of individuals with CKD who are aware of their disease, especially in Stages 1 to 3 CKD. A small increase in disease awareness has been seen in individuals with Stage 4 CKD (Figure 1.16).
- The prevalence of self-reported CKD is very low in the U.S. general population, as indicated in a large representative telephone based survey (BRFSS). Reports ranged from 1.8% in Virginia to 4.0% in Arizona. Given the overall prevalence of CKD in the U.S. population of about 14%, these numbers are consistent with limited awareness of CKD among those who have the condition (Figure 1.17).
- Life expectancy becomes progressively shorter with greater severity of CKD in all age groups, and is shorter for individuals with both albuminuria and low eGFR than for individuals with either albuminuria or low eGFR alone (Figure 1.18).

Introduction

This chapter presents representative cross-sectional estimates of chronic kidney disease (CKD) prevalence in the United States (U.S.), through analysis of 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 overall and in at-risk groups in the general U.S. population. NHANES data are released biennially; we primarily report trends based on four 4-year time periods within the last 16 years—1999–2002, 2003-2006, 2007-2010, and 2011-2014. These years include all data from the beginning of the "continuous" NHANES data collection. In previous

Annual Data Reports (ADRs) NHANES III (1988-1994) data were also included; we refer readers to the past ADRs for this information.

Utilizing data from the Behavioral Risk Factors Surveillance System (BRFSS; CDC 2015b), this year we also present the 2012 and 2014 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 considered to be 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?" In contrast to the NHANES data, with this data source contains participants' residence information, to allow some assessment of geographic distributions of self-reported kidney disease.

As the NHANES database does not contain diagnostic information, we developed criteria to identify individuals who potentially have 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/1.73m^2 are considered to have reduced kidney function. Secondly, we use the ACR to assess urinary albumin excretion, and consider four categories: <10 mg/g, 10-<30 mg/g, 30-300 mg/g, and >300 mg/g. Lastly, we consider a composite measure of both eGFR and ACR, classifying individuals as CKD if they have either an eGFR <60 ml/min/1.73m^2 *or* ACR ≥30 mg/g. Staging of kidney disease follows the Kidney Disease Outcomes and Quality Improvement (KDOQI) CKD guidelines (NKF, 2002).

Table A. Kidney Disease Outcomes and Quality Improvement (KDOQI) CKD Staging Guidelines

CKD Stage	Description	GFR (ml/min/1.73 m^2)
1	Kidney damage with normal or ↑ GFR	> 90
2	Kidney damage with mild ↓ in GFR	60-89
3	Moderate ↓ in GFR	30-59
4	Severe ↓ in GFR	15-29
5	Kidney failure	< 15 (or dialysis)

The biochemical data available in NHANES are used to evaluate kidney function through estimated glomerular filtration rate (eGFR), and kidney damage through urinary albumin excretion as estimated by urine albumin/creatinine ratio (ACR). Consistent with the assessment of the prevalence of other medical conditions in this national survey, both measures are based on laboratory specimens collected at a single point in time. In clinical practice, diagnosis of CKD typically requires multiple assessments of kidney function and urine albumin (or total protein) over weeks or months. In this case we must instead rely on a single, cross-sectional sample available for all participants in the four 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 may be higher than would be the case if measures of eGFR and urine albumin/creatinine ratio (ACR) were repeated over time to fulfill the KDIGO criteria of 'persistence for 3 months or longer' for the clinical diagnosis of CKD, due to fluctuations in eGFR or ACR.

In contrast, all 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. These classifications are more likely to miss the earlier stages of CKD. The NHANES data allows us to distinguish individuals within Stage 1 (eGFR >90 with ACR >30) and Stage 2 (eGFR >60 with ACR >30).

By providing NHANES data demonstrating level of kidney function and the related comorbidities of DM, HTN, and CVD in the general population, this chapter sets the stage for Chapter 2 of Volume 1, *Identification and Care of Patients with CKD*. There we discuss CKD as recognized in the health care system via analysis of Medicare claims, OPTUM, and Veterans Affairs data, providing information on morbidity, interventions, and costs.

Methods

Two nationally representative data sources were used in this chapter: NHANES (1999-2014) and BRFSS (2012, 2014).

The National Health and Nutrition Examination Survey (NHANES) is a sample of about 5,000 individuals per year from the U.S. civilian, noninstitutionalized population. Respondents answer survey questions and receive a medical examination including blood and urine samples tested for various biochemical markers, including serum creatinine and urine albumin. All tables and figures in this chapter use NHANES data except for Figure 1.17.

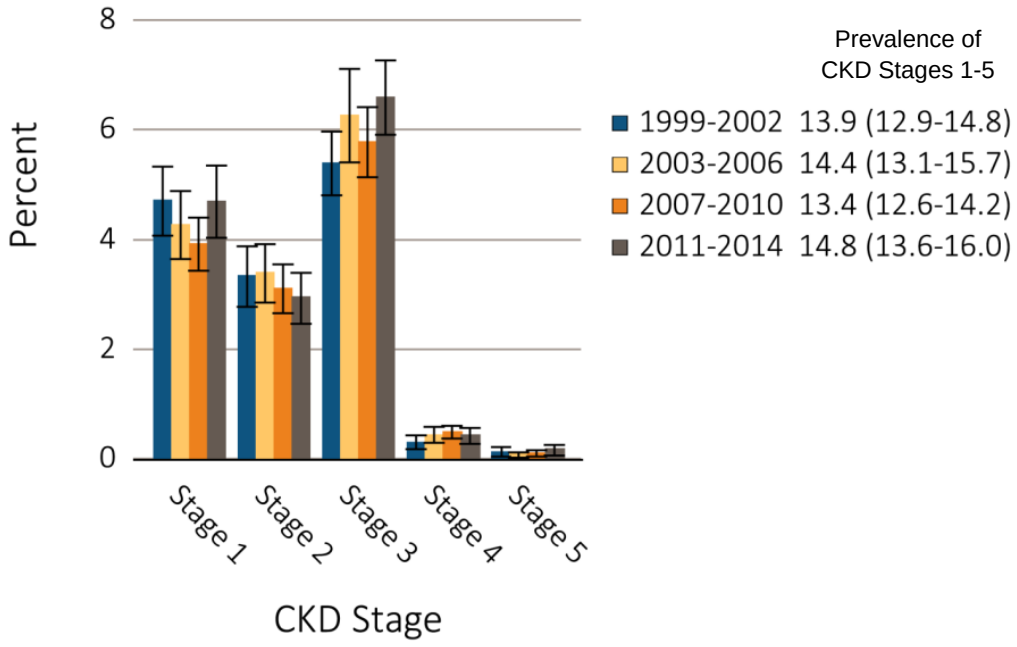
Figure 1.17 uses data from the Behavioral Risk Factor Surveillance System (BRFSS) to show estimates of self-reported kidney disease in smaller geographic regions. These data are also a sample of the U.S. general population, but respondents are asked survey questions during a phone interview, and there is no medical examination. However, the sample size is larger, allowing precise estimation for U.S. states.

A full explanation of these data and an explanation of the analytical methods used to generate the figures and tables in this chapter can be found in the *CKD Analytical Methods* chapter.

Prevalence of CKD

The prevalence of CKD in the United States over four periods from 1999 to 2014 is shown in Figure 1.1. This illustrates that the largest increase occurred in Stage 3 CKD, which rose from 5.4% to 6.6% over the four time periods. The percent of individuals in Stages 1 and 2 decreased from 1999-2010;Stage 2 continued to decrease but Stage 1 reverted to initial levels in the most recent time frame.

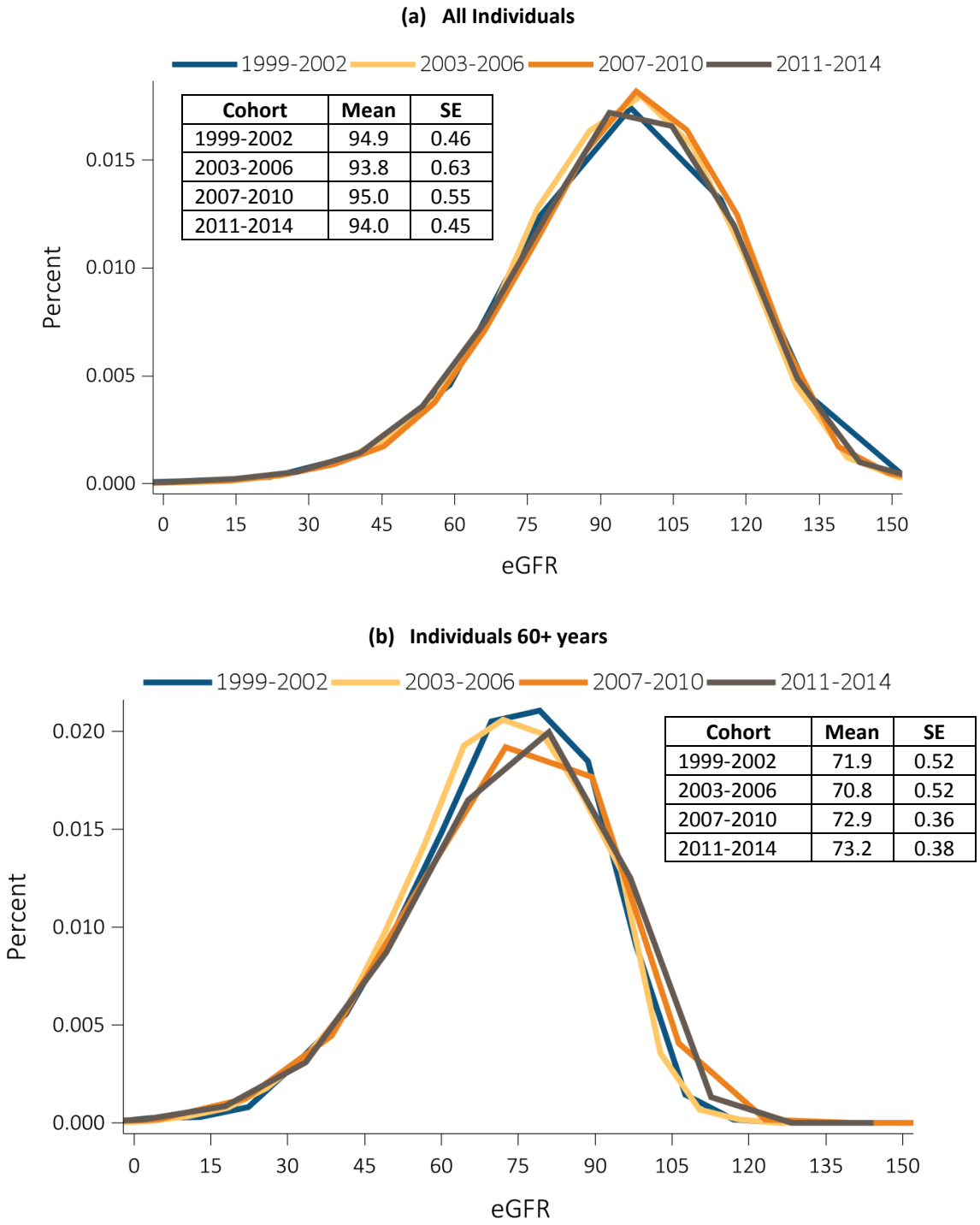
vol 1 Figure 1.1 Prevalence of CKD by stage among NHANES participants, 1999-2014



Data Source: National Health and Nutrition Examination Survey (NHANES), 1999-2002, 2003-2006, 2007-2010 & 2011–2014 participants aged 20 & older. Whisker lines indicate 95% confidence intervals. Abbreviation: CKD, chronic kidney disease.

Figure 1.2 provides the density distributions of eGFR in NHANES 1999-2002, 2003-2006, 2007-2010, and 2011-2014. Overall, minimal population changes have been observed over the entire period. We also examined these densities among individuals over the age of 60 years, as this group experiences the highest prevalence of CKD. The average eGFR for the individuals over 60 years was approximately 25 ml/min/1.72m² lower than for the full sample (Figure 1.2b).

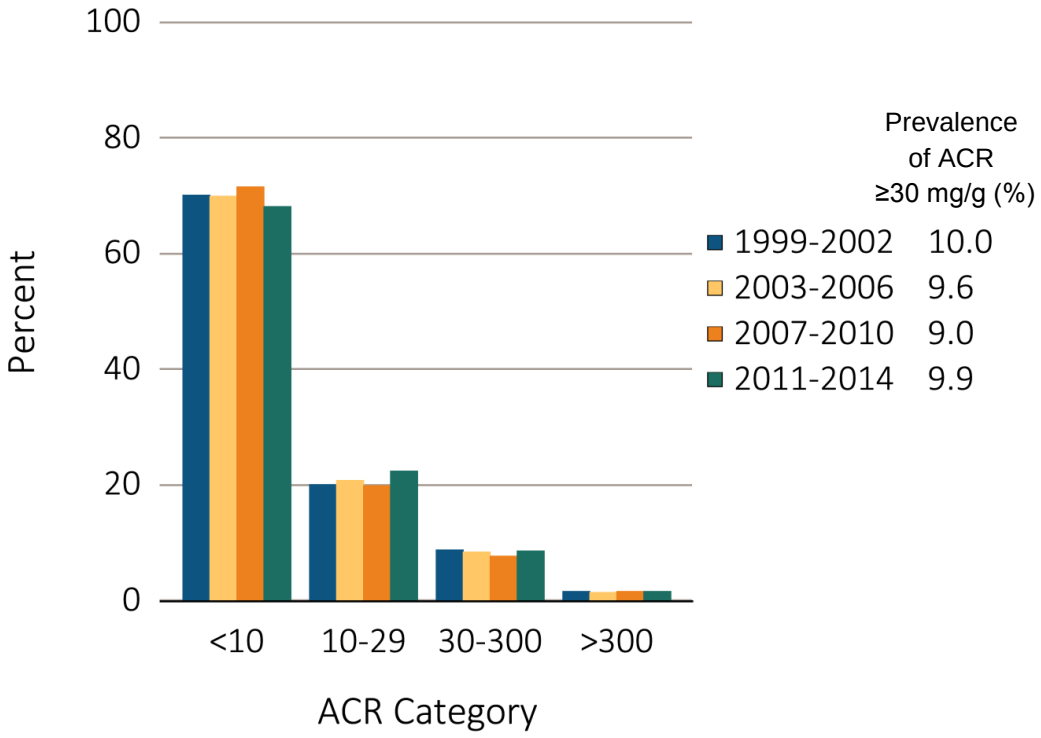
vol 1 Figure 1.2 eGFR distribution among NHANES participants, 1999-2014



Data Source: National Health and Nutrition Examination Survey (NHANES), 1999-2014 participants aged 20 & older. Single-sample estimates of eGFR; eGFR calculated using the CKD-EPI equation. Abbreviations: eGFR, estimated glomerular filtration rate; SE, standard error. Accounts for change in serum creatinine assays.

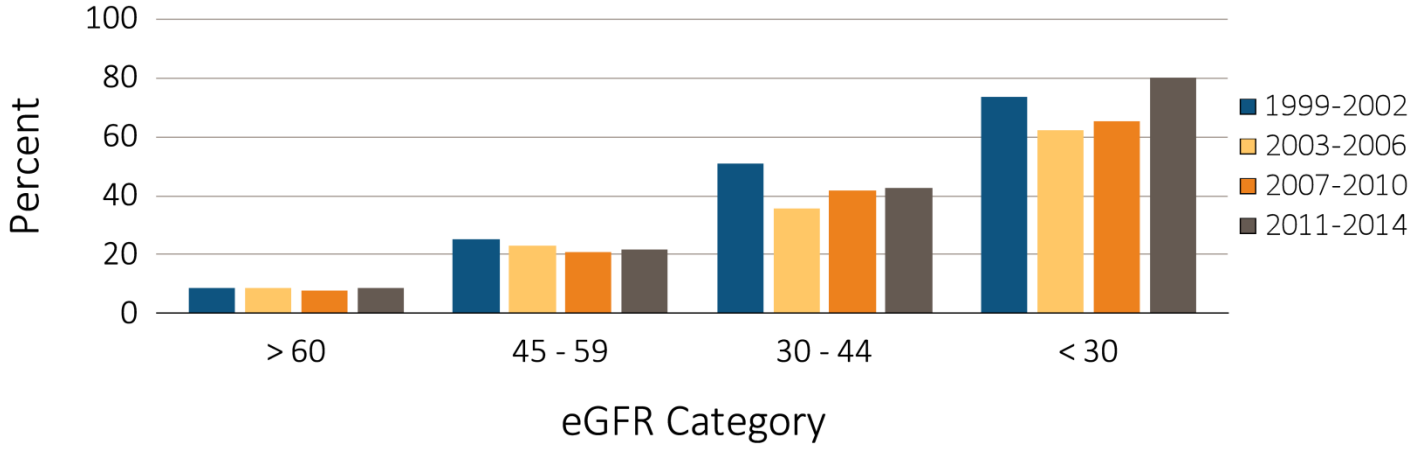
Figure 1.3, with corresponding findings for ACR, shows little change over time in the distribution patterns of individuals with ACR of 30-300 mg/g or ACR >300 mg/g. However, comparison of the groups with ACR <30 mg/g, shows a decrease in the proportion of individuals with ACR <10 and an increase in the proportion of individuals with ACR of 10 to <30 mg/g, over the four periods. This has important mortality implications, as increased rates of all-cause mortality have been seen with ACR values as low as 10 mg/g (versus 5 mg/g: HR = 1.20, 95% CI: 1·15-1·26; Matsushita, 2010).

vol 1 Figure 1.3 Urine albumin/creatinine ratio (ACR) distribution among NHANES participants, 1999-2014



Data Source: National Health and Nutrition Examination Survey (NHANES), 1999-2014 participants aged 20 & older. Single-sample estimates of ACR. Abbreviation: ACR, urine albumin (mg)/creatinine (g) ratio.

vol 1 Figure 1.4 Percentage of NHANES (1999-2014) participants with ACR >30 mg/g, by eGFR category



When assessing the joint distribution of eGFR and ACR, we observed higher prevalence of albuminuria with lower kidney function. For example, in the 2011 to 2014 NHANES sample, 6.5% of persons with normal kidney function (>90 eGFR ml/min/1.73m²) had some evidence of albuminuria (Table 1.1). This was 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 had evidence of albuminuria.

Over the four time periods there was an overall rise in the percentage of individuals in the three higher-risk KDIGO categories, increasing from 13.9% of 1999-2002 participants to approximately 15% in 2011-2014 (see Table 1.1b). Although the prevalence fluctuated over the four periods, it increased from 13.5% to 14.9% between the two most recent cohorts.

vol 1 Table 1.1 Percentage of NHANES 2011-2014 participants, in the various CKD (eGFR and albuminuria) risk categories (KDIGO 2012)

(a) Percentage in each category (2011-2014)

				Albuminuria categories		
				A1	A2	A3
				Normal to mildly increased	Moderately increased	Severely increased
				<30 mg/g <3 mg/mmol	30-300 mg/g 3-30 mg/mmol	>300 mg/g >30 mg/mmol
GFR categories (ml/min/1.73 m²)	G1	Normal to high	≥ 90	54.7	4.3	0.4
	G2	Mildly decreased	60-89	30.4	2.6	0.3
	G3a	Mildly to moderately decreased	45-59	3.9	0.9	0.2
	G3b	Moderately to severely decreased	30-44	1.0	0.5	0.2
	G4	Severely decreased	15-29	0.1	0.1	0.2
	G5	Kidney failure	< 15	<0.001	0.001	0.01

(b) Summary of prevalence in each risk category by cohort (1999-2014)

	1999-2002	2003-2006	2007-2010	2011-2014
Low risk	86.1	85.5	86.5	85.1
Moderately high risk	10.4	10.6	9.6	10.8
High risk	13.9 = 10.4 + 2.2 + 1.3	14.5 = 10.6 + 2.7 + 1.2	13.5 = 9.6 + 2.5 + 1.4	14.9 = 10.8 + 2.6 + 1.5
	2.2	2.7	2.5	2.6
Very high risk	1.3	1.2	1.4	1.5

Data source: National Health and Nutrition Examination Survey (NHANES), 1999-2002, 2003-2006, 2007-2010 & 2011–2014 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/1.73 m² or eGFR ≥60 ml/min/1.73 m² and ACR 30-300 mg/g; high risk: eGFR 30-44 ml/min/1.73 m² or eGFR 45-59 ml/min/1.73 m² and ACR 30-300 mg/g or eGFR ≥60 ml/min/1.73 m² and ACR >300 mg/g; very high risk: eGFR <30 ml/min/1.73 m² or eGFR 30-44 ml/min/1.73 m² and ACR 30-300 mg/g or eGFR ≥60 ml/min/1.73 m² and ACR >300 mg/g.

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 eGFR <60 ml/min/1.73 m² or an ACR ≥30 mg/g confirms a higher estimated prevalence in the presence of each of these risk factors, although with a smaller increase for BMI ≥30 kg/m² (Table 1.2). Other observations of interest include that CKD more prevalent in women and those over 60 years of age and DM is the most common comorbid risk factor for CKD. Ethnic and racial comparisons show that non-Hispanic Blacks have higher rates of ACR >30 but lower rates of eGFR <60 as compared to non-Hispanic Whites.

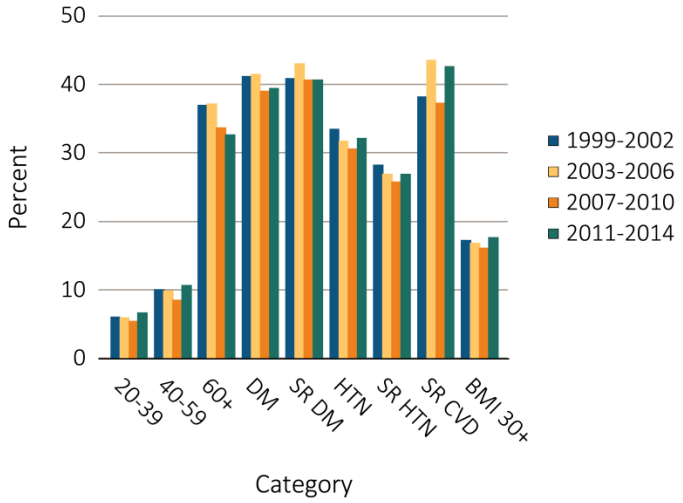
Occurrences of eGFR >60 ml/min/1.73 m² and ACR ≥30 mg/g for adult NHANES participants are shown in Table 1.2. When CKD was defined as either eGFR <60 or ACR ≥30, prevalence estimates varied over time, with an overall rise from 13.9% to 14.8% (Figure 1.5). The largest relative increase in prevalence was seen among those with SR CVD, where estimates rose from 38.2% in 1999-2002 to 42.6% in 2011-2014. The prevalence of eGFR <60 rose from 5.8 to 7.2% over the four periods, with the largest relative increase (1.7-fold) seen in those aged 40–59. Prevalence for ACR ≥30 remained steady over this period, between 9-10%.

vol 1 Table 1.2 Prevalence (%) of CKD in NHANES population within age, sex, race/ethnicity, & risk-factor categories, 1999-2014

	All CKD				eGFR <60 ml/min/1.73m^2				ACR ≥30 mg/g			
	1999-2002	2003-2006	2007-2010	2011-2014	1999-2002	2003-2006	2007-2010	2011-2014	1999-2002	2003-2006	2007-2010	2011-2014
Age												
20-39	6.0	5.9	5.4	6.6	0.4	0.1	0.3	0.3				
40-59	10.0	9.8	8.5	10.6	1.9	2.3	2.0	3.3	5.9	5.8	5.3	6.4
60+	36.9	37.1	33.6	32.6	24.0	25.8	22.9	22.6	8.6	8.2	7.0	8.5
Sex												
Male	12.0	12.6	11.7	13.0	4.8	5.7	5.2	6.4	9.1	8.9	8.4	8.8
Female	15.6	16.1	15.0	16.5	6.8	7.8	7.5	7.9	10.9	10.2	9.4	10.9
Race/Ethnicity												
Non-Hispanic White	13.9	14.3	13.8	15.2	6.6	7.9	7.5	8.5	9.3	8.5	8.4	9.0
Non-Hispanic Black/African American	15.1	15.8	14.8	16.9	5.3	5.2	5.8	6.2	12.7	13.0	11.2	13.5
Mexican American	11.6	11.6	11.8	12.5	1.4	1.6	2.3	2.5	10.4	10.9	10.5	11.2
Other Hispanic	13.8	15.5	11.4	12.8	3.6	3.5	3.3	4.3	11.7	13.3	9.5	10.5
Other Non-Hispanic	14.0	16.2	10.6	12.8	3.9	4.2	3.1	4.3	12.1	13.5	9.1	10.3
Risk Factor												
Diabetes	41.2	41.5	39.0	39.4	15.1	19.2	18.7	20.7	34.8	30.9	28.4	28.7
Self-reported diabetes	40.8	43.0	40.6	40.6	16.5	20.3	19.9	22.3	33.5	31.7	29.5	29.5
Hypertension	33.4	31.7	30.6	32.1	16.8	17.4	16.9	17.7	23.0	19.6	19.1	20.6
Self-reported hypertension	28.2	26.9	25.7	26.9	16.3	15.3	15.0	15.8	17.7	16.5	15.7	16.6
Self-reported cardiovascular disease	38.2	43.5	37.2	42.6	26.7	29.3	25.1	29.3	22.7	24.8	22.3	25.5
Obesity (BMI >30)	17.2	16.8	16.1	17.6	6.3	7.1	7.0	7.9	13.2	11.9	11.1	12.5
All	13.9	14.4	13.4	14.8	5.8	6.8	6.4	7.2	10.1	9.6	8.9	9.9

Data source: National Health and Nutrition Examination Survey (NHANES), 1999-2002, 2003-2006, 2007-2010 & 2011-2014 participants age 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Diabetes defined as HbA1c >7 percent, 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 1.3 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.

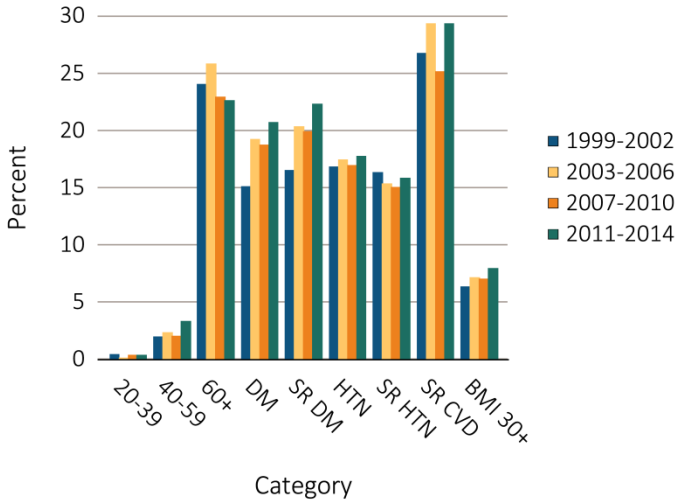
vol 1 Figure 1.5 Prevalence of CKD by age & risk factor among NHANES participants, 1999-2014



Data Source: National Health and Nutrition Examination Survey (NHANES), 1999–2014 participants age 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Diabetes defined as HbA1c >7 percent, 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: 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-reported.

Figure 1.6 shows that CKD defined by an eGFR <60 was much more prevalent in individuals aged 60 and older. Low eGFR was present in this age group for over 25.0% of the cohort of 2003-2006 participants, compared to 0.1% of individuals aged 20 to 39 years and 2.3% of those aged 40 to 59 years. The prevalence of low eGFR also rose in all other comorbidity categories over these time periods, especially for DM (15.1% to 20.7%). The prevalence of eGFR <60 increased for both sexes and for all races, although more so for non-Hispanic whites (6.6% to 8.5%), as shown in Table 1.2.

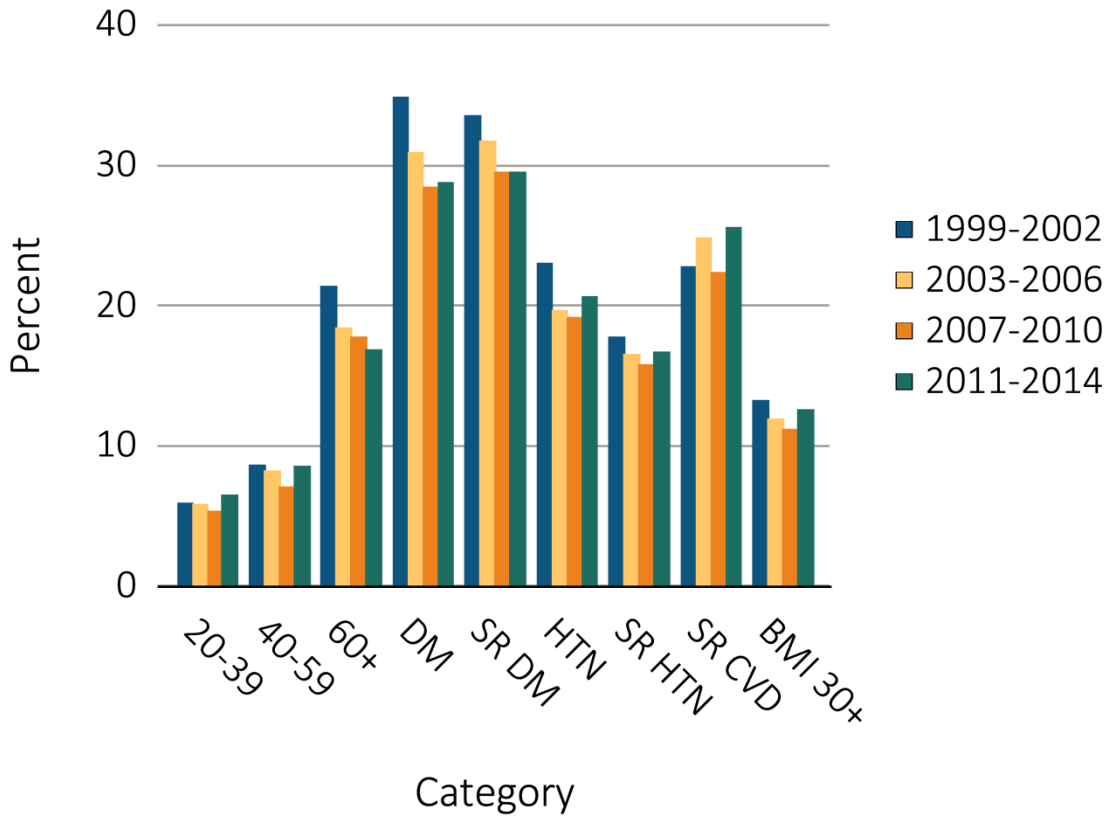
vol 1 Figure 1.6 NHANES participants with eGFR <60 ml/min/1.73 m^2, by age & risk factor, 1999-2014



Data Source: National Health and Nutrition Examination Survey (NHANES), 1999–2002, 2003-2006, 2007-2010, & 2011–2014 participants age 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Diabetes defined as HbA1c >7 percent, 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: ACR, urine albumin/creatinine ratio; BMI, body mass index; CVD, cardiovascular disease; DM, diabetes mellitus; eGFR, estimated glomerular filtration rate; HTN, hypertension; SR, self-reported.

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

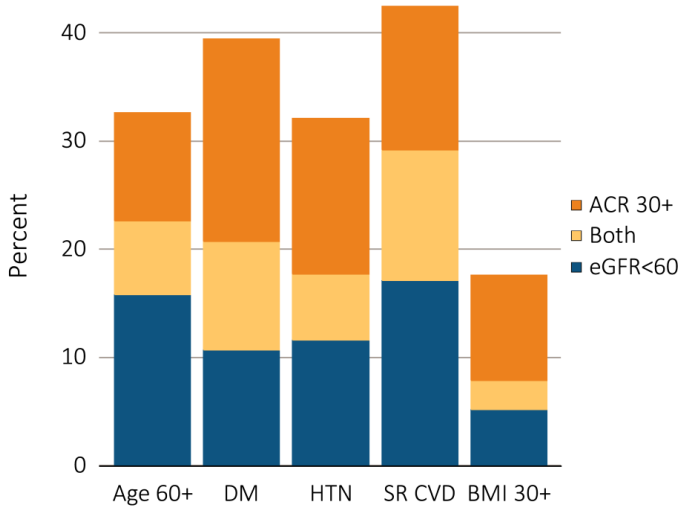
vol 1 Figure 1.7 NHANES participants with urine albumin/creatinine ratio ≥30 mg/g, by age & risk factor, 1999-2014



Data source: National Health and Nutrition Examination Survey (NHANES), 1999–2002, 2003-2006, 2007-2010 & 2011–2014 participants age 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Diabetes defined as HbA1c >7 percent, 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: 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.

Figure 1.8 displays the prevalence of CKD markers (eGFR <60 ml/min/1.73 m^2 and ACR ≥30 mg/g) among adult NHANES 2011–2014 participants—specifically those aged 60 years and older, and those of all ages who have the comorbid conditions of DM, HTN, SR CVD, and higher BMI. The prevalence of eGFR <60 was highest among those aged 60 years or older (22.6%) and those with SR CVD (29.2%), followed by those with DM, HTN, and higher BMI, at 20.7%, 17.7% and 9.9%, respectively. An ACR ≥30 was most common in those with DM, at 28.7%, followed by those with SR CVD (25.4%), with HTN (20.5%), aged 60 or older (16.8%), and of higher BMI (12.4%). The presence of both eGFR <60 and ACR ≥30 was most common with SR CVD, at 12.1%, followed by DM, those aged 60 years and older, with HTN, and with higher BMI, at 10.0%, 6.8%, 6.1%, and 2.7%, respectively.

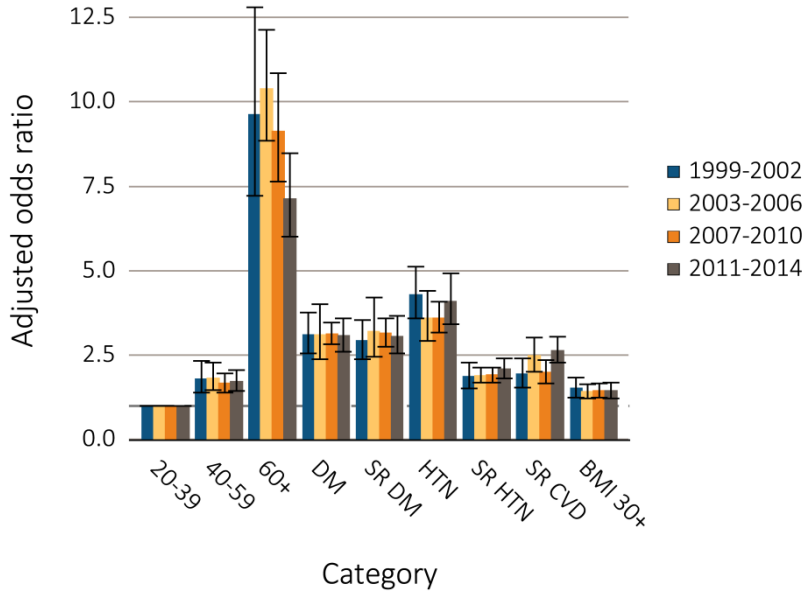
vol 1 Figure 1.8 Distribution of markers of CKD in NHANES participants with diabetes, hypertension, self-reported cardiovascular disease, & obesity, 2011–2014



Data Source: National Health and Nutrition Examination Survey (NHANES), 2011–2014 participants age 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; SR CVD, self-reported cardiovascular disease; eGFR, estimated glomerular filtration rate; HTN, hypertension.

Figures 1.9-1.11 illustrate the odds ratios for presence of CKD for each of the common comorbid conditions. Analyses were adjusted for age, sex, and race; as consistent with the reminder of this chapter, presence of CKD was indicated by either eGFR <60 ml/min/1.73 m² or ACR ≥ 30 mg/g.

vol 1 Figure 1.9 Adjusted odds ratios of CKD in NHANES participants by risk factor, 1999-2014

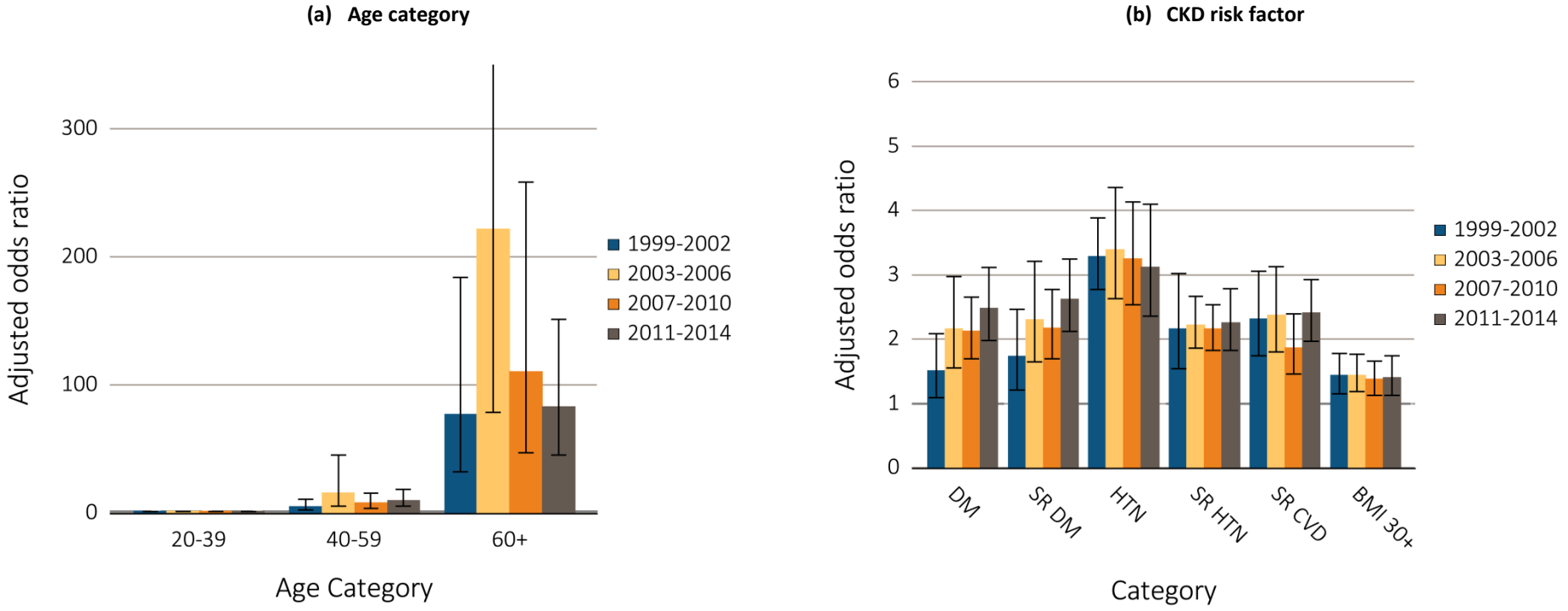


Data Source: National Health and Nutrition Examination Survey (NHANES), 1999–2002, 2003-2006, 2007-2010 & 2011–2014 participants age 20 & older; single-sample estimates of eGFR & ACR. Adj: age, sex, & race; eGFR calculated using the CKD-EPI equation. Whisker lines indicate 95% confidence intervals. Abbreviations: 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/1.73 m² or ACR ≥30 mg/g (Figure 1.9) were generally lower in NHANES 2003-2006, 2007–2010, and 2011-2014 participants than during 1999–2002. This was true for each risk factor except SR HTN and SR CVD, where adjusted odds ratios rose from 1.86 to 2.09 and 1.93 to 2.63, respectively. Age was the strongest factor associated with CKD, followed by HTN, DM and CVD; these comorbidities had about one third of the effect size as did age.

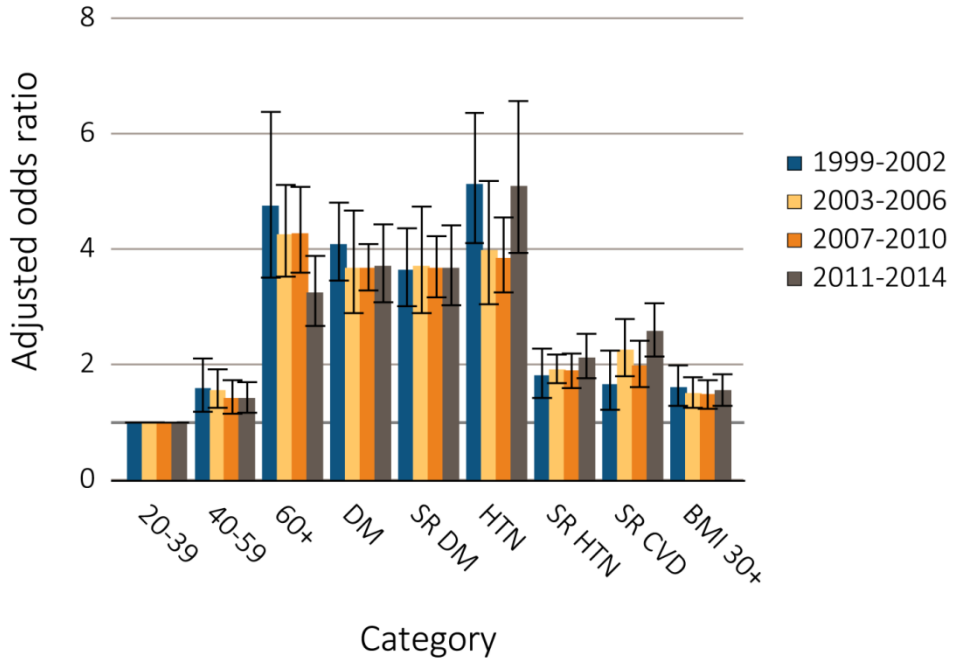
For eGFR <60 alone (Figure 1.10), adjusted odds ratios followed a similar pattern, except for DM and SR DM, where the odds increased from 1.6 to approximately 2.5 in both groups. Also, eGFR <60 showed a very strong association with age, with adjusted odds ratios in the 100 range. For ACR ≥30 alone (Figure 1.11), a substantial decline in the adjusted odds ratio is seen among both those with DM (from 4.08 to 3.69) and aged 60 or older (from 4.74 to 3.23), while a substantial increase in the adjusted odds ratio is seen for those self-reporting CVD (from 1.65 to 2.57).

vol 1 Figure 1.10 Adjusted odds ratios of eGFR <60 ml/min/1.73m2 in NHANES participants by age & risk factor, 1999-2014



Data Source: National Health and Nutrition Examination Survey (NHANES), 1999–2002, 2003-2006, 2007-2010 & 2011–2014 participants age 20 & older; single-sample estimates of eGFR & ACR. Adj: age, sex, & race; 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.

vol 1 Figure 1.11 Adjusted odds ratios of urine albumin/creatinine ratio ≥30 mg/g in NHANES participants by age & risk factor, 1999-2014



Data Source: National Health and Nutrition Examination Survey (NHANES), 1999–2002, 2003-2006, 2007-2010 & 2011–2014 participants age 20 & older; single-sample estimates of eGFR & ACR. Adjusted: age, sex, & race; 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.

Treatment of CKD

Table 1.3 presents awareness of hypertension, treatment of CKD-contributing conditions, and control of HTN, hyperlipidemia, and DM in NHANES adult participants with eGFR <60 ml/min/1.73 m² or ACR ≥30 mg/g. While the 73-74% prevalence of HTN among CKD patients was similar in the four periods, the proportion of participants unaware of their HTN fell from 64.3% to 22.6% in the same time frame. The proportion of hypertensive individuals, who were aware, treated, and disease controlled rose steadily from approximately 8% in the early cohorts to 28% in 2011-2014. In the subgroup with DM, glycemic control over time showed little improvement with 57.1% uncontrolled in 2011-2014. No improvement was seen in activity level or smoking status.

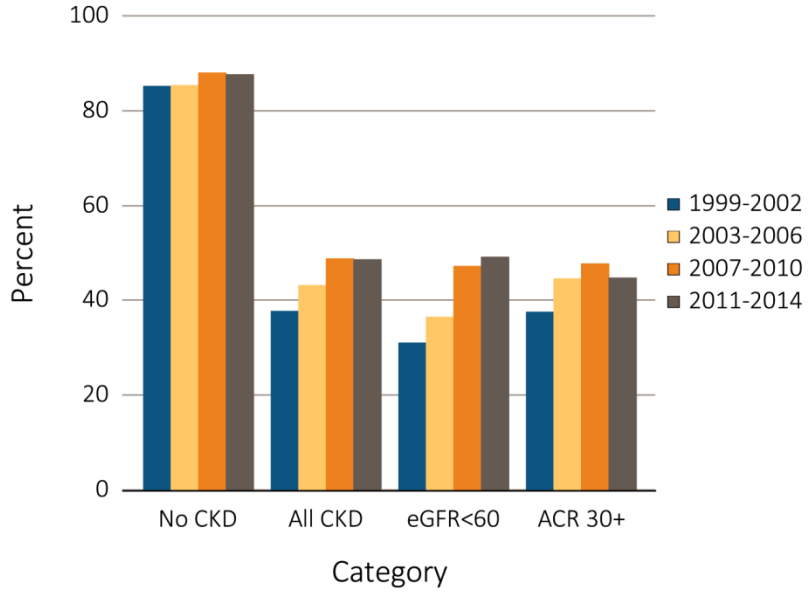
vol 1 Table 1.3 Awareness, treatment, & measures of control of CKD risk factors, percent of NHANES participants, 1999-2014

	All CKD					eGFR <60 ml/min/1.73m^2					ACR ≥30 mg/g				
	1999-2002	2003-2006	2007-2010	2011-2014	Trend p-value	1999-2002	2003-2006	2007-2010	2011-2014	Trend p-value	1999-2002	2003-2006	2007-2010	2011-2014	Trend p-value
Hypertension, by current hypertensive status[a]															
Non-hypertensive status	26.9	25.8	26.8	26.1	0.87	14.8	14.6	15.6	17.0	0.20	29.7	30.3	31.1	28.6	0.75
Hypertensive (measured/treated)	73.1	74.2	73.2	73.9		85.2	85.4	84.4	83.0		70.3	69.7	68.9	71.5	
Control of hypertension among hypertensive patients[b]															
Unaware	64.3	25.4	19.5	22.6		58.1	21.0	17.0	13.1		67.7	26.8	24.7	23.0	
Aware, not treated	5.6	8.4	9.7	5.8	***<0.001***	3.2	5.2	2.5	4.3	***<0.001***	6.6	10.3	8.2	12.6	***<0.001***
Aware, treated, uncontrolled	22.1	46.6	42.3	43.8		26.6	51.4	45.5	45.8		21.1	46.3	44.9	43.9	
Aware, treated, controlled	8.0	19.6	28.5	27.8		12.1	22.4	35.0	36.8		4.7	16.5	22.1	20.5	
Total cholesterol[c]															
<200 (desirable)	43.2	53.1	59.2	61.6		40.7	56.6	62.6	64.3		44.9	52.8	58.2	61.3	
200–239 (borderline high)	35.3	27.5	26.3	24.1	***<0.001***	37.0	25.8	23.5	22.0	***<0.001***	34.2	27.7	27.2	24.8	***<0.001***
240+ (high)	21.5	19.4	14.5	14.4		22.3	17.6	13.9	13.7		20.9	19.5	14.6	13.9	
Physical Activity															
Vigorous	22.4	20.8	20.6	23.3		14.0	14.8	13.0	16.9		24.2	22.9	23.5	24.7	
Moderate	31.5	35.7	34.6	33.1	0.47	32.0	39.0	35.0	33.9	0.55	30.5	33.6	32.9	31.6	0.65
Sedentary	46.1	43.5	44.8	43.6		53.9	46.2	52.0	49.2		45.3	43.5	43.6	43.7	
Smoking															
Current	16.6	16.2	15.0	15.0		7.4	8.7	8.4	9.1		20.4	20.1	18.7	18.6	
Former	31.6	31.8	31.6	33.3	0.93	39.2	38.1	39.0	39.8	0.38	28.7	29.3	28.9	30.6	0.87
Never	51.8	52.0	53.4	51.7		53.4	53.2	52.6	51.1		50.9	50.6	52.5	50.8	
Control of diabetes among patients with diabetes[d]															
Glycohemoglobin <7% (controlled)	32.8	51.1	46.9	42.9		45.6	62.5	55.9	49.3		28.8	45.3	40.1	36.8	
Glycohemoglobin 7% or higher (uncontrolled)	67.2	48.9	53.1	57.1	0.20	54.4	37.5	44.1	50.7	0.57	71.2	54.7	59.9	63.2	0.37

Data Source: National Health and Nutrition Examination Survey (NHANES), 1999–2002, 2003-2006, 2007-2010 & 2011–2014 participants age 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. 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. Glycohemoglobin classified according to American Diabetes Association guidelines.

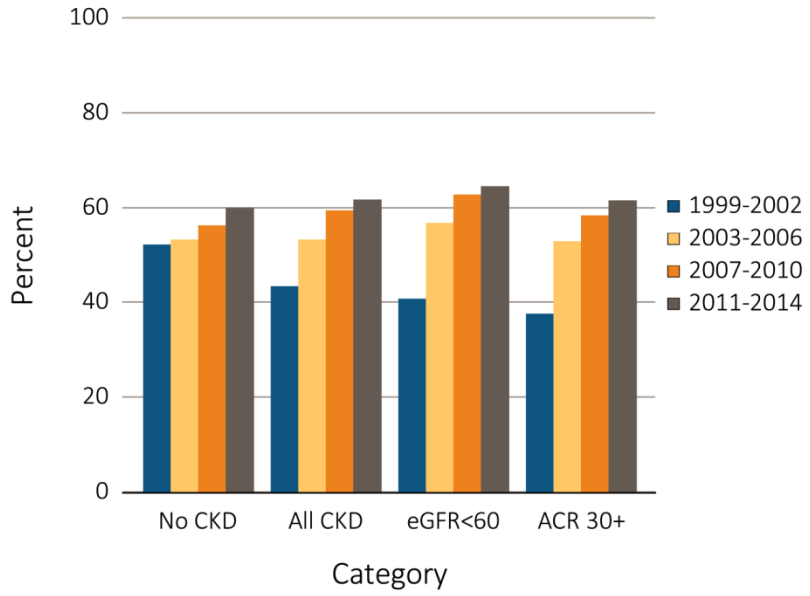
As illustrated by Figures 1.12-1.15, over the periods of 1999–2002, 2003-2006, 2007-2010 & 2011–2014, improvements in the management of HTN and cholesterol were observed, regardless of whether eGFR or ACR level was used as the criteria. These figures include estimates for individuals without CKD for comparison.

vol 1 Figure 1.12 NHANES participants at target blood pressure, 1999-2014



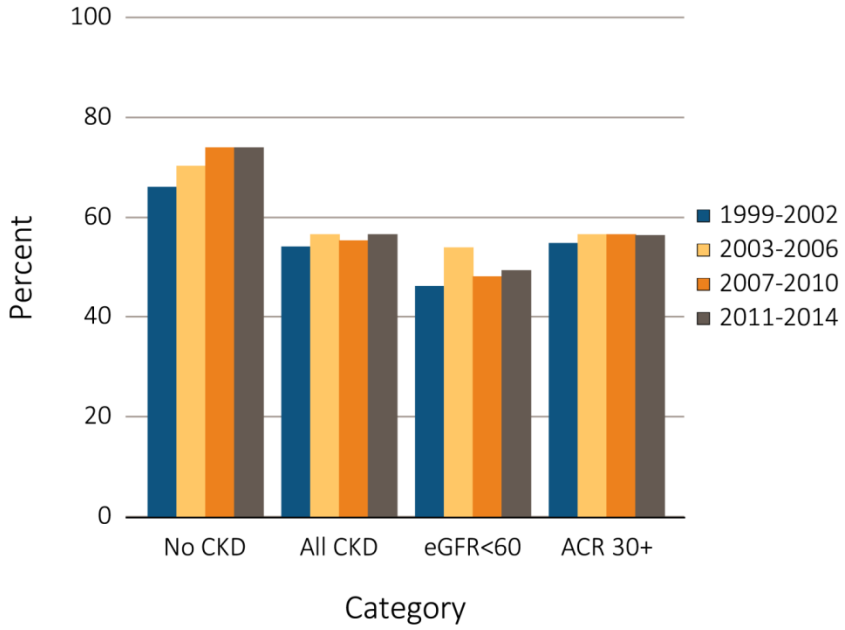
Data Source: National Health and Nutrition Examination Survey (NHANES), 1999-2002, 2003-2006, 2007-2010 & 2011–2014 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Figure represents all hypertensive participants including those who were 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 cholesterol normal range, 1999-2014



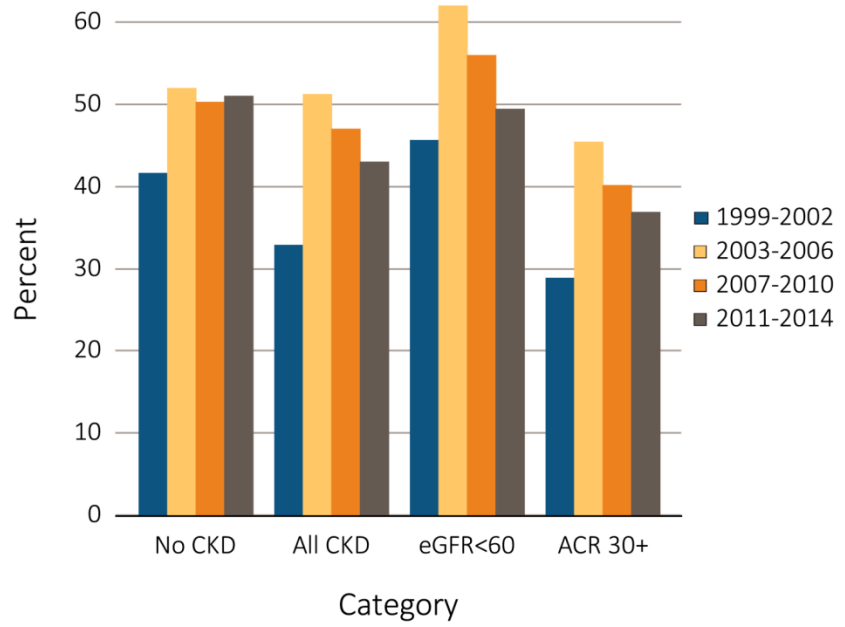
Data Source: National Health and Nutrition Examination Survey (NHANES), 1999-2002, 2003-2006, 2007-2010 & 2011–2014 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

vol 1 Figure 1.14 NHANES participants physically active, 1999-2014



Data Source: National Health and Nutrition Examination Survey (NHANES), 1999-2002, 2003-2006, 2007-2010 & 2011–2014 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%, 1999-2014

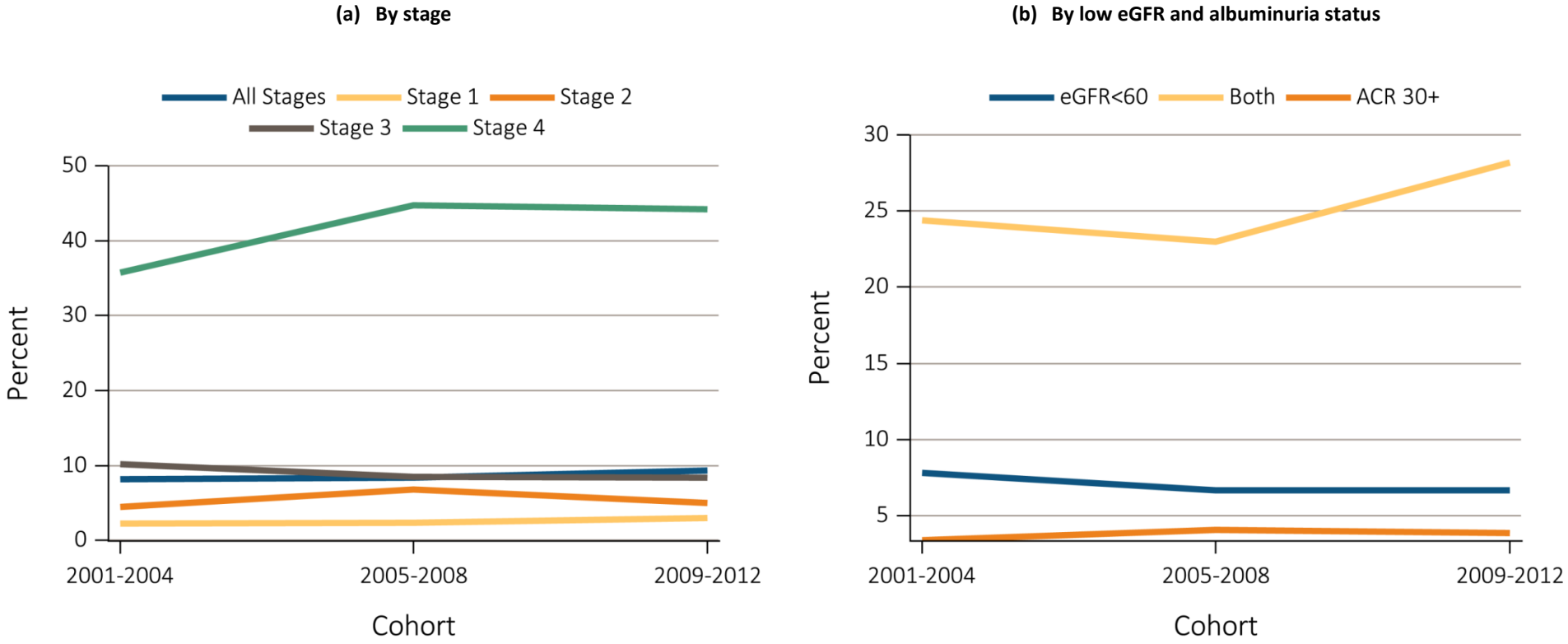


Data Source: National Health and Nutrition Examination Survey (NHANES), 1999-2002, 2003-2006, 2007-2010 & 2011–2014 participants aged 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation. Abbreviations: ACR, urine albumin/creatinine ratio; CKD, chronic kidney disease; eGFR, estimated glomerular filtration rate.

CKD Awareness

Among the individuals that were classified by laboratory measurements as having CKD, the percent of those individuals being aware of their kidney disease has remained low over the years from 2001-2012 (Figure 1.16). There is some suggestion of an improvement among individuals with Stage 4 CKD between 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. Awareness data is not presented for Stage 5 CKD due to a very small sample size. When examined by eGFR <60 vs. ACR >30, awareness was markedly higher for individuals who had both conditions.

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

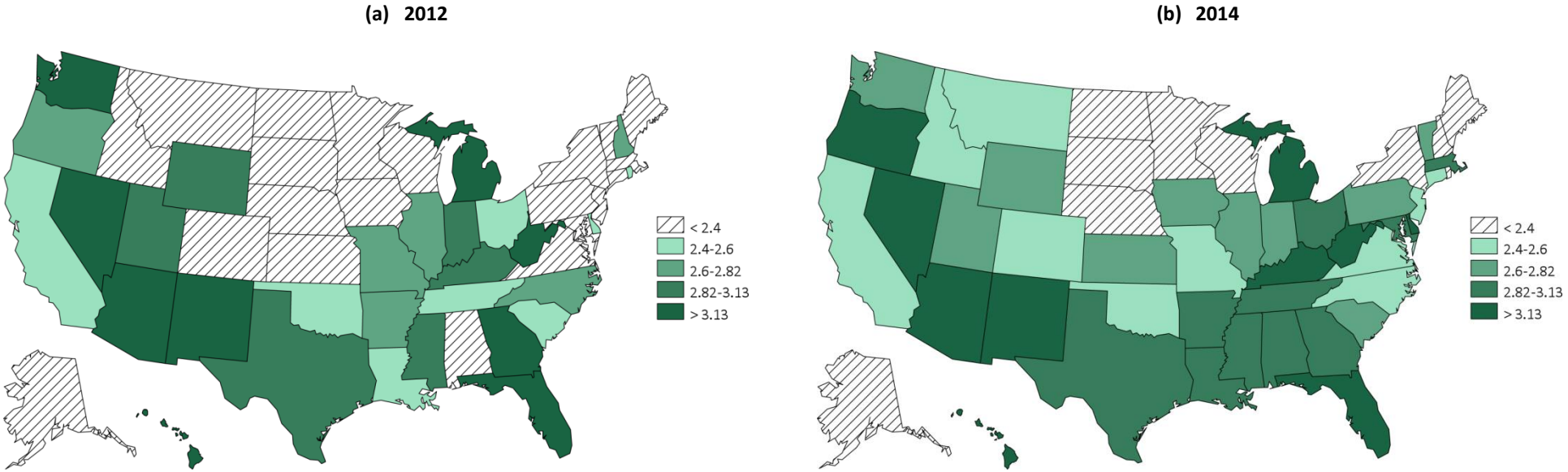


Data Source: National Health and Nutrition Examination Survey (NHANES), 2001-2012 participants aged 20 & older. Abbreviations: CKD, chronic kidney disease.

Figure 1.17 displays the state-specific proportion of individuals who reported being told they had 'kidney disease' based on the 2012 and 2014 BRFSS sample. The overall national means were very low at 2.7% and 2.8%, respectively. Also at 2.8%, the NHANES prevalence of self-reported kidney disease ('weak or failing kidneys') 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 indicated that they had been informed that they had kidney disease in both years included Hawaii, Arizona, Florida, New Mexico, Michigan, West Virginia, and Nevada. Conversely,

the states with the lowest proportion reporting kidney disease included Wisconsin, North Dakota, and Minnesota. 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 who have the condition, or a combination of both.

vol 1 Figure 1.17 Estimated prevalence of self-reported kidney disease by state (%), BRFSS participants ages 18 and older, 2012 (N=471,107) & 2014 (N=464,617)

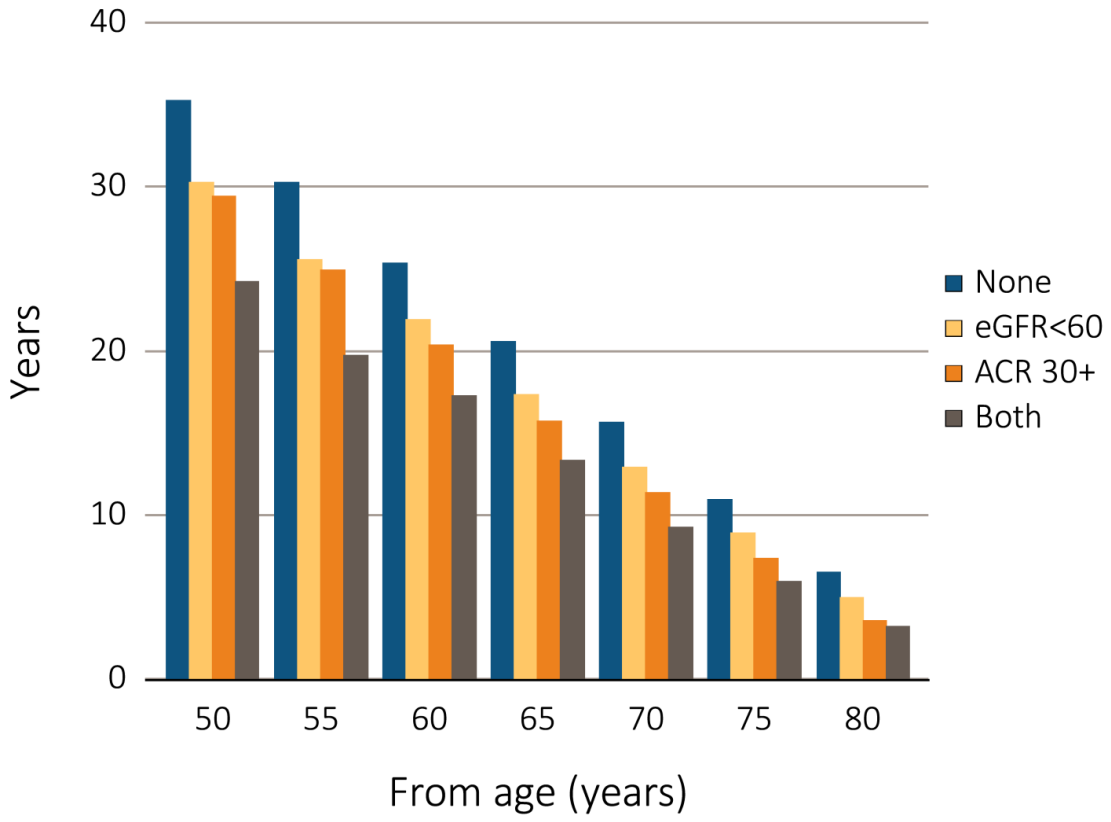


Data source: Behavioral Risk Factors Surveillance System (BRFSS), 2012 participants aged 18 & older.

Life Expectancy

Figure 1.18 shows life expectancy estimates for adult NHANES 1999–2011 participants with single-sample estimates of GFR and ACR. At age 50, estimated life expectancy for subjects with normal range eGFR and ACR was 35.2 years. The reduction in life expectancy associated with eGFR <60 ml/min/1.73 m² was five years, or 14.2% of the 35.2 years. Participants with ACR ≥30 mg/g had a reduction in estimated life expectancy of 5.8 years (16.5%); this became an 11 year reduction (31.3%) for those with both conditions. When life expectancy was calculated from successively older starting points, absolute reductions declined and percentage reductions remained similar.

vol 1 Figure 1.18 Life expectancy of NHANES participants with or without CKD, 1999–2011



NHANES 1999–2011 participants age 20 & older. Single-sample estimates of eGFR & ACR; eGFR calculated using the CKD-EPI equation.

References

Centers for Disease Control and Prevention (CDC). *Behavioral Risk Factors Surveillance System (BRFSS).* Website. Retrieved May 6, 2015 from http://www.cdc.gov/brfss/index.html

Centers for Disease Control and Prevention (CDC). *Data Files and Data Dictionaries: 2011 Public-use Linked Mortality Files* . Website. Retrieved July 25, 2016 from http://www.cdc.gov/nchs/data_access/data_linkage/mortality/data_files_data_dictionaries.htm

Centers for Disease Control and Prevention (CDC). *National Health and Nutrition Examination Survey* (NHANES). Website. Retrieved May 6, 2015 from http://www.cdc.gov/nchs/nhanes.htm

Kidney Disease: Improving Global Outcomes (KDIGO) CKD Work Group. KDIGO 2012 clinical practice guideline for the evaluation and management of chronic kidney disease. *Kidney Int Suppl* 2013;3(1):1–150.

Levey AS, Stevens LA, Schmid CH, Zhang YL, Castro AF, Feldman HI, Kusek JW, Eggers P, Van Lente F, Greene T, Coresh J. A new equation to estimate glomerular filtration rate. *Annals of Internal Medicine* 2009;150(9):604-612.

Matsushita K, van der Velde M, Astor BC, Woodward M, Levey AS, de Jong PE, Coresh J, Gansevoort RT. Association of estimated glomerular filtration rate and albuminuria with all-cause and cardiovascular mortality in general population cohorts: a collaborative meta-analysis. Lancet. 2010 June 12;375(9731):2073-81.

National Kidney Foundation. K/DOQI Clinical Practice Guidelines for Chronic Kidney Disease: Evaluation, Classification and Stratification. *American Journal of Kidney Diseases* 2002: suppl 1 (39): S1-S266.