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Prevalence, Trends and Functional Impairment Associated with Reduced Estimated Glomerular Filtration Rate and Albuminuria among the Oldest-Old US Adults

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Abstract

Background—The prevalence of reduced estimated glomerular filtration rate (eGFR) among US adults ≥ 80 years old increased between 1988–1994 and 2005–2010. Trends in the prevalence of albuminuria over this time period have not been reported in this population.

Methods—We conducted a cross-sectional analysis of US adults ≥ 80 years old in the National Health and Nutrition Examination Survey 1988–1994 (n=1,020), 1999–2004 (n=995) and 2005–2010 (n=971) to calculate the prevalence of albuminuria (albumin-to-creatinine ratio [ACR] ≥ 30 mg/g) by calendar period. The number of US adults ≥ 80 years with elevated ACR and separately, reduced eGFR, was calculated by calendar period.

Results—Among participants ≥ 80 years of age, the prevalence of albuminuria was 30.9%, 33.0% and 30.6% in 1988–1994, 1999–2004, and 2005–2010 (p-trend=0.9). The proportion of US adults ≥ 80 years old with both eGFR < 45 ml/min/1.73 m^2 and ACR ≥ 30 mg/g increased from 6.8% in 1988–1994 to 8.4% and 9.5% in 1999–2004, and 2005–2010, respectively (p-trend=0.008). In 1988–1994, 1999–2004, and 2005–2010 there were 1.78 (95% confidence interval, 1.29–2.27), 2.35 (1.93–2.78), and 2.74 (2.32–3.16) US adults ≥ 80 years old with albuminuria and 2.34 (1.79–2.89), 3.55 (2.96–4.14), and 4.58 (3.87–5.28) million, respectively, with eGFR < 60 ml/min/1.73 m^2.

Conclusions—The proportion of US adults ≥ 80 years of age with an elevated ACR remained relatively stable between 1988–1994 through 2005–2010. However, due to the growth of the oldest-old, the absolute number with albuminuria increased substantially over the past two decades.

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INTRODUCTION

The prevalence of reduced estimated glomerular filtration rate (eGFR) increases with age.[1,2] Several studies have shown that older adults with an eGFR < 60 ml/min/1.73 m^2 are at increased risk for complications such as hypertension, anemia and bone and mineral disease and adverse health outcomes including mortality, cardiovascular disease and kidney failure.[3–6] Reduced eGFR is also associated with other problems that are common among older adults such as functional decline and mobility impairment.[7,8]

We recently showed an increase in the prevalence of reduced eGFR between 1988–1994 and 2005–2010 among US adults ≥ 80 years old.[1] The recently updated Kidney Disease Improving Global Outcomes (KDIGO) Clinical Practice Guidelines for the Evaluation and Management of Chronic Kidney Disease recommend classification of CKD by eGFR category and albumin-to-creatinine ratio (ACR) category.[9] The addition of ACR category to CKD classification has been reported to provide prognostic information and guide referral and treatment decisions, especially among those with mild-to-moderate reduction in eGFR (i.e., 45 to 59 ml/min/1.73 m^2). Similar to reduced eGFR, the prevalence of albuminuria increases with age. However, contemporary data and trends in the prevalence of albuminuria among the oldest-old have not been reported.

Further description of the prevalence and trends of albuminuria among the oldest-old may be useful for the implementation of the KDIGO guidelines. Therefore, the primary aim of the current study was to determine the trends in prevalence of albuminuria from 1988–1994 through 2005–2010 among a representative sample of US adults ≥ 80 years old. Additionally, we examined trends in the joint distributions of eGFR and ACR over calendar time and the prevalence of functional impairment by level of eGFR and ACR. Finally, because of the aging of the US population, the number of US adults ≥ 80 years old is increasing. Therefore, we estimated the number of US adults ≥ 80 years with reduced eGFR and albuminuria over calendar time and provide projections for 2030 and 2050.

METHODS

Study participants

The National Health and Nutrition Examination Surveys (NHANES) is conducted by the National Center for Health Statistics (NCHS) and includes cross-sectional, multistage, stratified clustered probability samples of the US civilian non-institutionalized population. The current analysis used NHANES data from the 1988–1994 surveys (1988–1991 and 1991–1994) and from the 1999–2010 surveys (1999–2000, 2001–2002, 2003–2004, 2005–2006, 2007–2008, and 2009–2010). Detailed methods of the design and conduct of NHANES are available on-line.[10] This analysis was limited to participants 80 years of age and older who completed a medical evaluation in the NHANES mobile examination center (n=4,571). After excluding those who had eGFR <15 ml/min/1.73 m^2 or were missing serum creatinine, urinary albumin or urinary creatinine measurements, 2,986 participants had complete data for the current analyses of trends in prevalence of reduced eGFR and albuminuria from 1988–1994 (n=1,020), 1999–2004 (n=995) and 2005–2010 (n=971). NHANES cycles were pooled into three time periods (1988–1994, 1999–2004 and 2005–

2010) to achieve more reliable estimates. The protocol for each NHANES was approved by the NCHS of the Centers for Disease Control and Prevention Institutional Review Board. Informed consent was obtained from each participant.

Data collection

Age, sex, and race/ethnicity were obtained via self-report. Although there was no exclusion for older age, the exact age in years is provided in the public use NHANES data set for participants ≤ 90 years in NHANES 1988–1994, ≤ 85 years for NHANES 1999–2006, and ≤ 80 for NHANES 2007–2010. Above these cut-points, exact age was not available (e.g., everyone ≥ 90 years of age in NHANES III was assigned 90 years for their age) in the public use NHANES data set. Therefore, for the current analysis, all participants were assigned a uniform age of 80 years. Participants were considered current smokers if they reported current smoking in NHANES 1988–1994 or smoking “some days” or “most days” in NHANES 1999–2010. Waist circumference was measured mid-way between the lowest rib and the iliac crest with the participant standing. Using the average of all available blood pressure measurements, hypertension was defined as a systolic blood pressure ≥ 140 mmHg, diastolic blood pressure ≥ 90 mmHg or self-reported use of antihypertensive medication. Diabetes mellitus was defined by a prior diagnosis, excluding during pregnancy, with concurrent use of insulin or oral hypoglycemic medication, fasting glucose ≥ 126 mg/dL or non-fasting glucose ≥ 200 mg/dL.

Impairment in activities of daily living (ADL) was defined as answering “some difficulty,” “much difficulty” or “unable to do” to at least one of the questions including “how much difficulty do you have walking from room to room,” “getting in or out of bed,” “eating” or “dressing”. Impairment in instrumental activities of daily living (IADL) was defined as answering “some difficulty,” “much difficulty” or “unable to do” to at least one of the questions including “how much difficulty do you have doing chores around the house,” “preparing own meals and managing money.” Mobility impairment was defined as answering “some difficulty,” “much difficulty” or “unable to do” to at least one of the questions including “how much difficulty do you have walking a quarter mile” or “10 steps without rest.”

Measures of kidney function

After corrections for serum creatinine values for NHANES 1988–1994 and NHANES 1999–2000 and 2005–2006 were made,[11] eGFR was estimated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation. eGFR was categorized as ≥ 60, 45 to 59, and < 45 ml/min/1.73 m^{2}.[12] Urine albumin-to-creatinine ratio (ACR) was calculated from spot urine albumin and creatinine samples obtained during study visits. Albuminuria was defined as an ACR ≥ 30 mg/g.

Statistical Analyses

For each calendar period (1988–1994, 1999–2004, and 2005–2010), characteristics of the study population were calculated by level of eGFR (< 60 and ≥ 60 ml/min/1.73 m^{2}) and separately, by level of ACR (≥ 30 and < 30 mg/g). Next, the distribution of the eGFR (≥ 60, 45 to 59 and < 45 ml/min/1.73 m^{2}) and ACR (≥ 30 and < 30 mg/g), separately, was

calculated by calendar period. Additionally, the joint distribution of eGFR and ACR was calculated by calendar period. The prevalence of ADL, IADL, and mobility impairment was calculated by level of eGFR and level of ACR for each calendar period.

The number of US adults ≥ 80 years old with reduced eGFR (< 60 ml/min/1.73 m^2 overall, and subdivided into 45 to 59 and < 45 ml/min/1.73 m^2) and the number with an ACR ≥ 30 mg/g was calculated by calendar period. Based on the prevalence of reduced eGFR and albuminuria from NHANES 2005–2010 in combination with US Census Bureau projections, we estimated the number of US adults ≥ 80 years old with reduced eGFR and elevated ACR for 2030 and 2050.[13] This calculation accounts for the growth and aging of the US populations, but assumes the prevalence of reduced eGFR and ACR ≥ 30 mg/g will remain constant. Data management was conducted using SAS 9.2 (SAS Institute, Cary, NC) and all analyses were performed using SUDAAN 10.1 (Research Triangle Institute, Research Triangle Park, NC) accounting for the complex sampling design of NHANES. Sampling weights were applied to all calculations to obtain US nationally representative prevalence estimates. These weights adjust for the unequal probabilities of selection of participants, over-sampling of certain populations, and participant non-response. NHANES sampling weights were recalibrated based on the proportion of participants missing data by sex and race-ethnicity.[14] Recalibration of the sampling weights corrects for differences in missing data across sex and race-ethnicity strata, and assumes that data within strata are missing randomly.

RESULTS

Participant Characteristics

The gender and racial composition of the population did not change substantially from 1988–1994 to 2005–2010 (Table 1). For individuals with eGFR < 60 ml/min/1.73 m^2 and for their counterparts with eGFR ≥ 60 ml/min/1.73 m^2, waist circumference increased and diastolic blood pressure was lower over calendar time. Additionally, among those with hypertension, the proportion on antihypertensive medication increased over calendar time. A modest increase in the prevalence of diabetes was present among those with eGFR < 60 ml/min/1.73 m^2, but not those with eGFR ≥ 60 ml/min/1.73 m^2 across calendar periods. Participant characteristics by ACR < 30 versus ≥ 30 mg/g and calendar period are displayed in Table 2.

Trends in the prevalence of reduced eGFR and albuminuria

Among US adults ≥ 80 years of age, an increase in the prevalence of reduced eGFR, but not albuminuria was seen from 1988–1999 through 2005–2010 (Figure 1; Supplemental Table 1). Among participants ≥ 80 years of age, the prevalence of eGFR < 45 ml/min/1.73 m^2 with concurrent ACR < 30 mg/g increased from 7.6% in1988–1994 to 10.2% and 12.2% in 1999–2004 and 2005–2010, respectively (p-trend = 0.003; Table 3). The prevalence of eGFR < 45 ml/min/1.73 m^2 with concurrent ACR ≥ 30 mg/g also increased over calendar period and was 6.8%, 8.4%, and 9.5% in 1988–1994, 1999–2004, and 2005–2010, respectively (p-trend = 0.008).

Trends in functional impairment by eGFR level

Trends in ADL, IADL and mobility impairment by level of eGFR and separately, ACR, are displayed in Table 4. Over 25% of those with eGFR ≥ 60 and 45 to 59 ml/min/1.73 m^2, had impairments in ADLs, IADLs, and mobility, however no trends were seen over time in these groups. Among those with eGFR levels < 45 ml/min/1.73 m^2, no trends were present in ADL and IADL impairment, but the prevalence of mobility impairment increased from 60.5% in 1988–1994 to 66.4% and 72.2% in 1999–2004, and 2005–2010, respectively (p=0.039). Among those with ACR ≥ 30 mg/g, ADL impairment increased from 31.5% in 1988–1994 to 34.6% and 38.2% in 1999–2004 and 2005–2010, respectively.

Number of US adults ≥ 80 years of age with reduced eGFR and albuminuria

The number of US adults ≥ 80 years old with eGFR < 60 ml/min/1.73 m^2 was 2.34 (95% confidence interval [CI], 1.79–2.89), 3.55 (95% CI, 2.96–4.14), and 4.58 (95% CI, 3.87–5.28) million in 1988–1994, 1999–2004, and 2005–2010, respectively (Figure 2, Supplemental Table 2). The number of US adults ≥ 80 years old with eGFR < 45 ml/min/1.73 m^2 increased progressively over calendar time from 0.83 (95% CI, 0.59–1.08) million in 1988–1994 to 1.32 (95% CI, 1.03–1.61) and 1.95 (95% CI, 1.58–2.32) million in 1999–2004 and 2005–2010, respectively. The number of US adults ≥ 80 years old with an ACR ≥ 30 mg/g increased progressively over calendar time from 1.78 (95% CI, 1.29–2.27) million in 1988–1994 to 2.35 (95% CI, 1.93–2.78) million and 2.74 (95% CI, 2.32–3.16) million in 1999–2004 and 2005–2010, respectively. The number of US adults ≥ 80 years old with an eGFR < 45 ml/min/1.73 m^2 and an ACR ≥ 30 mg/g was 0.39 (95% CI, 0.26–0.52) million, 0.60 (95% CI, 0.44–0.76) million and 0.85 (95% CI, 0.66–1.05) million in 1988–1994, 1999–2004, and 2005–2010, respectively.

By 2030, we project there will be 9.94 (95% CI, 9.26–10.63) million US adults ≥ 80 years old with eGFR < 60 ml/min/1.73 m^2, (5.72 [95% CI, 5.11–6.33] and 4.22 [95% CI, 3.69–4.76] with eGFR of 45–59 and < 45 ml/min/1.73 m^2, respectively; Figure 2, Supplemental Table 2). This is projected to increase to 15.81 (95% CI, 14.72–16.90) million US adults ≥ 80 years in 2050 (9.10 [95% CI, 8.13–10.07] and 6.71 [95% CI, 5.87–7.56] million with eGFR of 45–59 and < 45 ml/min/1.73 m^2, respectively). The number of US adults ≥ 80 years old with ACR ≥ 30 mg/g is projected to be 5.95 (95% CI, 5.42–6.49) million and 9.47 (95% CI, 8.62–10.32) million in 2030 and 2050, respectively.

DISCUSSION

The current analysis of serial national cross-sectional samples indicates the number of US adults ≥ 80 years of age (i.e., the oldest-old), with eGFR < 60 ml/min/1.73 m^2 increased by more than two million people from 1988–1994 through 2005–2010. While the number of US adults ≥ 80 years of age with ACR ≥ 30 mg/g increased by nearly one million people over the past two decades, the proportion with elevated ACR remained relatively stable suggesting this increase is likely due to the aging of the US population. In an analysis of the joint distribution of eGFR and ACR, we found a trend of increasing prevalence of the oldest old with an eGFR < 45 ml/min/1.73 m^2 and an ACR ≥ 30 mg/g. In contrast, the prevalence of albuminuria did not increase among those with eGFR 45 to 59 ml/min/1.73 m^2. Lastly,

the number of US adults ≥ 80 years old with CKD is expected to increase three-fold by 2050 of which nearly 7 million will have an eGFR < 45 ml/min/1.73 m^2 and 9.5 million will have an ACR ≥ 30 mg/g.

A prior study demonstrated an increase in the prevalence of CKD between 1988–1994 and 1999–2004 for the general US population.[2] Also, a marked increase in the prevalence of reduced eGFR was noted for US adults ≥ 70 years of age. However, trends in CKD prevalence among those ≥ 80 years of age were not presented. Further, the joint distribution of reduced eGFR and ACR was not reported. The current study extends the prior report of an increasing prevalence of CKD in the general US population to the oldest old. Additionally, we found that a relatively stable prevalence of the lowest risk group of people with CKD (i.e., eGFR 45 to 59 ml/ml/min/1.73 m^2 and ACR < 30 mg/g).

When taken together with prior studies suggesting increased risk for adverse outcomes at lower eGFR levels and higher ACR levels,[3,6,15] findings from the current analysis have important clinical implications. Prior studies of general population and young to middle age adult samples have found the majority of those with CKD have only mild-to-moderate reductions in eGFR (45 to 59 ml/min/1.73 m^2).[16] In contrast, in the current study of the oldest-old, the proportion with eGFR < 45 ml/min/1.73 m^2 was substantial and increased over the last two decades. This was true for both those with and without albuminuria. Based on the 2012 CKD clinical practice guidelines, an individual with an eGFR 45–59 ml/min/1.73 m^2 and ACR < 30 mg/g, would be classified as G3aA1 with recommendations for yearly monitoring for disease progression.[9] In contrast, an individual with an eGFR 30–44 ml/min/1.73 m^2 and an ACR 30–300 mg/g would be classified as a G3bA2. For this individual, guidelines recommend monitoring kidney disease progression three times per year and for lower blood pressure targets to be considered.

Further, our findings suggest that while functional impairment has been relatively stable over the last two decades, there remains a high burden of functional impairment in this population. Among US adults 80 years and older with eGFR < 60 ml/min/1.73 m^2, more than 1 in 3 reported difficulty with IADLs, tasks that are necessary for independent living. Also, the prevalence of impaired mobility was even higher and among those with eGFR < 45 ml/min/1.73 m^2, and mobility impairment increased between 1988–1994 and 2005–2010 for both those without and without albuminuria in this group. Preparing to care for the nearly 10 million octogenarians with reduced eGFR by 2030, will require innovative healthcare models that involve care coordination, facilitate shared-decision making, and include interdisciplinary teams to address not only measures of kidney function and related comorbidities, but the complex physical, cognitive, social and psychological needs of these patients.[17]

The findings from the present analyses should be interpreted within the context of known and potential limitations. We relied on serial cross-sectional samples of US adults and information on intra-individual longitudinal changes of kidney function was not available. Recent studies have demonstrated that there is substantial heterogeneity in kidney function trajectories in individuals with CKD and that many people have stable kidney function for long periods of time.[18,19] In the current analysis, we were not able to evaluate within-person

changes in kidney function. Although the development, internal validation and external validation data sets did include a small number of participants > 80 years of age, the CKD-EPI equation has not been validated in a large elderly US population with measured GFR.[12] In one study, the CKD-EPI equation was shown to overestimate GFR among individuals > 70 years of age, however, this study was limited to a white, European population.[20] Several studies have shown the predictive validity for CKD-EPI eGFR and renal complications and outcomes in older populations.[3–5] Exact age was not available for all NHANES participants for estimating GFR. For this reason, we used the age of 80 years in the CKD-EPI estimating equation for all participants. As older age in the CKD-EPI equation results in a lower eGFR, we overestimated eGFR for some participants who were older than 80 years and our findings likely underestimate the prevalence of CKD. Also, NHANES was limited to community-dwelling older adults and may not accurately reflect the prevalence reduced eGFR among older adults residing in nursing homes. Additionally, older adults who participated in NHANES surveys may be healthier than older nonparticipants or nursing home residents leading to the underestimation of the true prevalence of reduced eGFR among the oldest old.

In conclusion, the prevalence of albuminuria did not increase between 1988–1994 and 2005–2010 among US adults ≥ 80 years of age. However, the prevalence of having an eGFR < 45 ml/min/1.73 m^2 with albuminuria did increase over this time period. Additionally, the number of US adults ≥ 80 years of age with eGFR < 60 ml/min/1.73 m^2 increased by more than two million over this time period and the number with ACR ≥ 30 mg/g increased by almost one million adults. Furthermore, we project the number of US adults ≥ 80 years of age with eGFR < 60 ml/min/1.73 m^2 and with ACR ≥ 30 mg/g will double by 2030 and will be three- to four-fold higher by 2050. Because of the growing burden of moderate-to-severe CKD, steps may be necessary now to develop an interdisciplinary geriatric nephrology work force trained in the unique aspects of caring for older adults with CKD and capable of engaging older patients in shared decision-making regarding dialysis and other treatment options.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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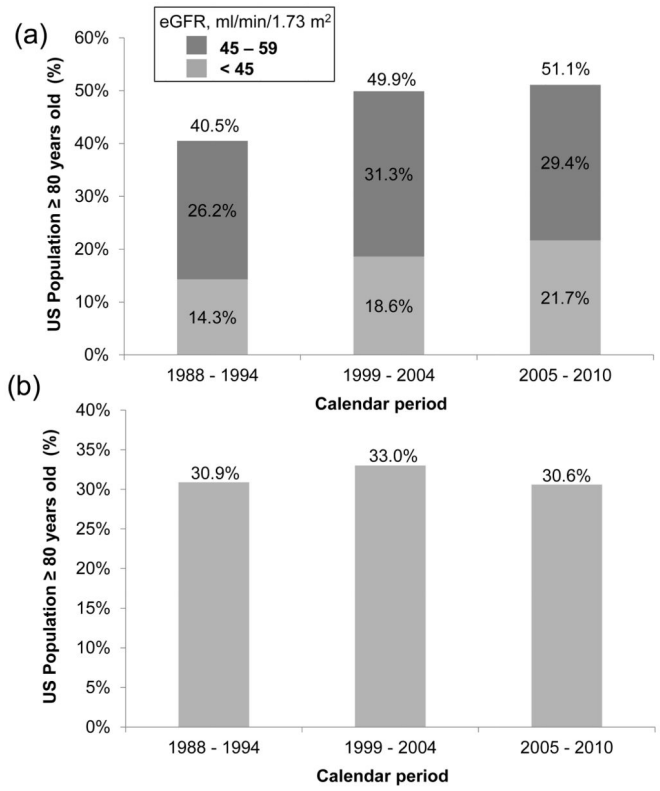

Figure 1.

Prevalence of (a) reduced estimated glomerular filtration rate (eGFR) and (b) albumin-to-creatinine ratio (ACR) ≥ 30 mg/g among US adults ≥ 80 years old by calendar period

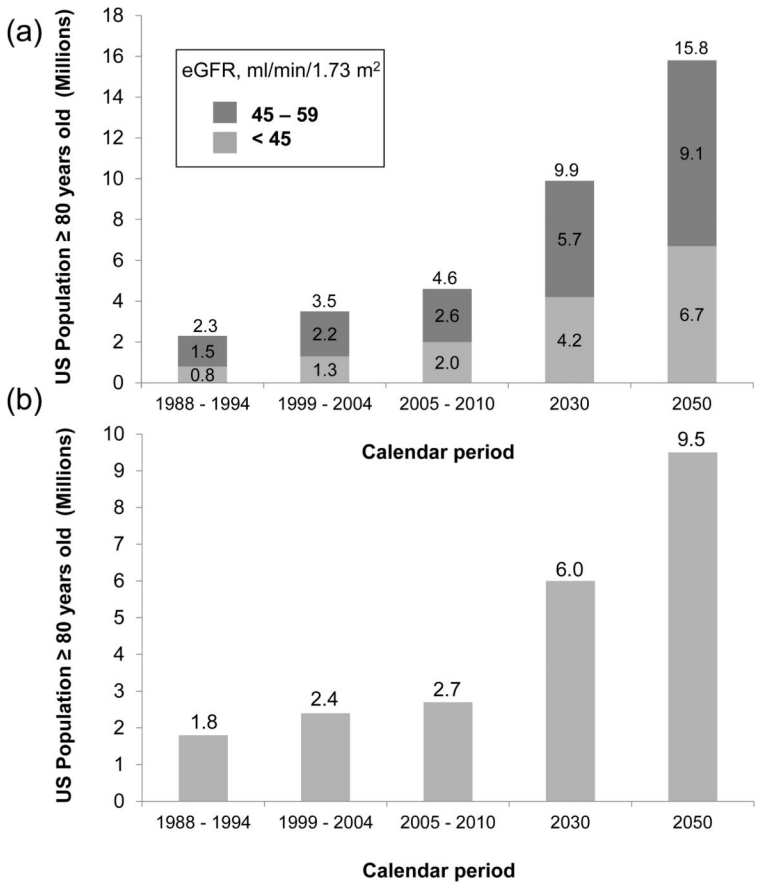

Figure 2.

Number of US adults ≥ 80 years old with (a) reduced estimated glomerular filtration rate (eGFR) and (b) albumin-to-creatinine ratio (ACR) ≥ 30 mg/g by calendar period.

Table 1

Characteristics of NHANES participants ≥ 80 years of age by level of estimated glomerular filtration rate (eGFR) and calendar period.

	eGFR ≥ 60 ml/min/1.73m^2			eGFR < 60 ml/min/1.73m^2		
Participant Characteristic	**1988–1994 (n=611)**	**1999–2004 (n=518)**	**2005–2010 (n=488)**	**1988–1994 (n=409)**	**1999–2004 (n=477)**	**2005–2010 (n=483)**
Women, %	66.0 (2.2)	66.3 (2.2)	59.0 (2.2)	63.1 (3.3)	62.1 (2.9)	64.8 (1.9)
Race-ethnicity, %						
Non-Hispanic white	86.8 (2.1)	85.0 (2.3)	85.5 (2.5)	91.6 (1.5)	87.3 (2.4)	89.2 (1.6)
Non-Hispanic black	6.6 (1.4)	6.4 (1.4)	6.0 (1.2)	5.9 (1.2)	6.6 (1.4)	5.1 (0.9)
Mexican-American	1.9 (0.3)	5.5 (1.3)	5.1 (1.0)	1.1 (0.3)	4.8 (2.1)	2.9 (0.6)
Other	4.7 (1.3)	3.1 (1.4)	3.4 (1.2)	1.4 (0.7)	1.3 (0.5)	2.8 (1.0)
Current smoker, %	5.7 (1.3)	4.6 (0.7)	2.4 (0.7)	3.8 (1.0)	3.2 (0.8)	3.4 (0.9)
Waist circumference, cm	93.0 (0.5)	94.7 (0.5)	95.7 (0.6)	94.8 (0.6)	97.7 (0.6)	98.3 (0.7)
Systolic BP, mmHg	147.7 (0.6)	149.3 (1.0)	141.5 (1.0)	149.0 (1.4)	148.1 (1.7)	137.9 (1.0)
Diastolic BP, mmHg	71.2 (0.4)	62.7 (1.3)	59.9 (0.7)	72.0 (0.7)	60.1 (1.0)	58.3 (0.9)
Hypertension, %	69.3 (1.6)	73.8 (1.7)	69.5 (2.2)	78.5 (2.4)	77.4 (1.6)	81.7 (2.0)
Antihypertensive medication *, %	43.4 (3.4)	52.1 (3.5)	70.7 (3.6)	54.8 (3.1)	75.2 (2.0)	81.4 (2.2)
Diabetes mellitus, %	12.0 (1.5)	11.3 (1.5)	13.7 (2.1)	12.7 (1.8)	15.9 (1.7)	18.4 (2.0)

Numbers in table are percentage (standard error) or mean (standard deviation).

eGFR – estimated glomerular filtration rate

* Restricted to people with hypertension

Table 2

Characteristics of NHANES participants ≥ 80 years of age by level of albumin-to-creatinine ratio (ACR) and calendar period.

	ACR < 30 mg/g			ACR ≥ 30 mg/g		
Participant Characteristic	**1988–1994 (n=707)**	**1999–2004 (n=669)**	**2005–2010 (n=656)**	**1988–1994 (n=313)**	**1999–2004 (n=326)**	**2005–2010 (n=315)**
Women, %	64.2 (2.2)	63.7 (1.9)	63.6 (2.0)	66.2 (3.6)	65.2 (2.5)	58.1 (2.5)
Race-ethnicity, %						
Non-Hispanic white	88.8 (1.8)	86.6 (2.1)	89.5 (1.4)	88.7 (2.3)	85.3 (3.1)	82.5 2.9)
Non-Hispanic black	6.4 (1.3)	6.6 (1.3)	4.9 (0.8)	6.2 (1.5)	6.3 (1.6)	7.1 (1.4)
Mexican-American	1.4 (0.3)	4.6 (1.2)	3.5 (0.7)	2.1 (0.6)	6.2 (2.8)	5.0 (1.1)
Other	3.5 (1.2)	2.2 (1.0)	2.1 (0.6)	3.0 (1.2)	2.2 (0.9)	5.4 (1.8)
Current smoker, %	4.7 (1.0)	3.9 (0.8)	2.7 (0.5)	5.4 (1.9)	3.8 (1.3)	3.5 (1.2)
Waist circumference, cm	93.9 (0.5)	96.1 (0.4)	97.2 (0.5)	93.3 (0.6)	96.3 (0.7)	96.6 (0.8)
Systolic BP, mmHg	145.4 (0.9)	143.8 (0.9)	137.5 (0.9)	154.7 (1.6)	158.7 (1.8)	144.5 (1.5)
Diastolic BP, mmHg	70.7 (0.5)	60.5 (0.9)	58.6 (0.7)	73.5 (0.9)	63.3 (1.7)	60.3 (1.6)
Hypertension, %	67.7 (1.9)	71.1 (1.6)	72.8 (1.8)	84.8 (2.1)	84.7 (2.6)	82.4 (2.5)
Antihypertensive medication *, %	47.1 (3.1)	64.0 (2.3)	75.5 (2.1)	50.7 (3.4)	63.7 (3.5)	78.8 (3.3)
Diabetes mellitus, %	8.6 (1.2)	12.3 (1.5)	12.0 (1.2)	20.4 (2.5)	16.2 (2.4)	25.4 (2.6)

Numbers in table are percentage (standard error) or mean (standard deviation).

*Restricted to people with hypertension

Table 3

Joint distribution of estimated glomerular filtration rate (eGFR) and level of albumin-to-creatinine ratio (ACR) among NHANES participants ≥ 80 years of age by calendar period.

	Calendar Period			
	1988–1994 (n=1,020)	**1999–2004 (n=995)**	**2005–2010 (n=971)**	**p-trend**
eGFR ≥ 60, ml/min/1.73m^2				
ACR < 30 mg/g	43.8 (2.2)	36.5 (1.8)	35.7 (2.2)	ref
ACR ≥ 30 mg/g	15.7 (1.7)	13.7 (1.3)	13.1 (1.1)	0.889
eGFR 45 to 59 ml/min/1.73m^2				
ACR < 30 mg/g	17.8 (1.5)	20.3 (1.4)	21.4 (1.5)	0.019
ACR ≥ 30 mg/g	8.4 (0.9)	11.0 (1.1)	8.0 (0.8)	0.3061
eGFR < 45 ml/min/1.73m^2				
ACR < 30 mg/g	7.6 (1.0)	10.2 (1.4)	12.2 (1.3)	0.003
ACR ≥ 30 mg/g	6.8 (0.9)	8.4 (1.0)	9.5 (1.1)	0.008

Numbers in table are percentage (standard error).

ACR – albumin-to-creatinine ratio; eGFR – estimated glomerular filtration rate

Table 4

Prevalence of activities of daily living (ADL), instrumental activities of daily living (IADL) and mobility impairment among US adults ≥ 80 years of age by level of estimated glomerular filtration rate (eGFR) and albumin-to-creatinine ratio (ACR).

	Calendar Period			
	1988–1994 (n=1,020)	**1999–2004 (n=995)**	**2005–2010 (n=971)**	**p-trend**
eGFR ≥ 60ml/min/1.73 m^2				
ADL impairment, %	30.0 (2.4)	26.1 (2.7)	29.3 (3.8)	0.818
IADL impairment, %	35.5 (3.1)	34.8 (2.9)	28.4 (2.8)	0.108
Mobility impairment, %	51.4 (3.3)	50.0 (2.8)	51.4 (3.7)	0.985
eGFR 45 to 59 ml/min/1.73 m^2				
ADL impairment, %	26.7 (2.4)	35.0 (2.7)	26.3 (3.0)	0.905
IADL impairment, %	35.3 (3.9)	40.2 (3.5)	34.9 (3.2)	0.926
Mobility impairment, %	54.1 (3.5)	59.0 (3.6)	55.6 (3.7)	0.771
eGFR < 45 ml/min/1.73 m^2				
ADL impairment, %	28.8 (3.5)	34.9 (3.7)	32.0 (3.1)	0.560
IADL impairment, %	42.7 (3.9)	49.5 (5.0)	37.1 (2.9)	0.170
Mobility impairment, %	60.5 (5.0)	66.4 (5.1)	72.2 (2.9)	0.039
ACR < 30 mg/g				
ADL impairment, %	27.8 (2.0)	28.6 (2.1)	24.9 (2.7)	0.398
IADL impairment, %	31.6 (2.3)	37.4 (2.5)	29.5 (2.2)	0.540
Mobility impairment, %	50.1 (2.9)	54.0 (2.2)	52.9 (2.5)	0.447
ACR ≥ 30 mg/g				
ADL impairment, %	31.5 (2.7)	34.6 (2.9)	38.2 (2.9)	0.090
IADL impairment, %	47.4 (5.1)	43.1 (3.7)	38.5 (3.1)	0.143
Mobility impairment, %	60.8 (4.4)	59.5 (3.2)	66.7 (2.9)	0.273

Numbers in table are percentage (standard error)

ACR – albumin-to-creatinine ratio; eGFR – estimated glomerular filtration rate