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Association of CKD with Disability in the United States

Laura C. Plantinga, ScM¹, Kirsten Johansen, MD², Deidra C. Crews, MD, ScM³, Vahakn B. Shahinian, MD⁴, Bruce M. Robinson, MD⁵, Rajiv Saran^{4,5}, Nilka Rios Burrows, MPH⁶, Desmond E. Williams, MD, PhD⁶, and Neil R. Powe, MD, MPH, MBA¹ on behalf of the CDC CKD Surveillance Team

¹Department of Medicine, San Francisco General Hospital and University of California, San Francisco, CA

²Department of Medicine, San Francisco VA Medical Center and University of California, San Francisco, CA

³Department of Medicine, Johns Hopkins School of Medicine, Baltimore, MD

⁴Department of Medicine, University of Michigan, Ann Arbor, MI

⁵Arbor Research Collaborative for Health, Ann Arbor, MI

⁶Division of Diabetes Translation, Centers for Disease Control and Prevention, Atlanta, GA

Abstract

Background—Little is known about disability in early-stage chronic kidney disease (CKD).

Study Design—Cross-sectional national survey (National Health and Nutrition Examination Survey 1999–2006).

Setting and Participants—Community-based survey of 16,011 non-institutionalized U.S. civilian adults (≥20 years).

Predictor—CKD, categorized as: no CKD, stages 1 and 2 [albuminuria and estimated glomerular filtration rate (eGFR) ≥60 ml/min/1.73 m²], and stages 3 and 4 (eGFR 15–59).

Outcome—Self-reported disability, defined by limitations in working, walking, and cognition; and difficulties in activities of daily living (ADL), instrumental ADL, leisure and social activities, lower extremity mobility, and general physical activity.

Measurements—Albuminuria and eGFR assessed from urine and blood samples; disability, demographics, access to care, and comorbid conditions assessed by standardized questionnaire.

Results—Age-adjusted prevalence of reported limitations was generally significantly greater with CKD: *e.g.*, difficulty with ADLs was reported by 17.6%, 24.7%, and 23.9% of older (≥65 years) and 6.8%, 11.9%, and 11.0% of younger (20–64 years) adults with no CKD, stages 1 and 2, and stages 3 and 4, respectively. CKD was also associated with greater reported limitations and

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Correspondence: Laura Plantinga, San Francisco General Hospital and University of California, San Francisco, 1001 Potrero Avenue, Building 10, Floor 3, San Francisco, CA 94110. Phone: 415-206-6007; Fax: 415-206-5586; plantinga@medsfgh.ucsf.edu.
***N section:** A list of the members of the CDC CKD Surveillance Team appears at the end of this article.

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difficulty in other activities after age adjustment, including instrumental ADL, leisure and social activities, lower extremity mobility, and general physical activity. Other demographics, socioeconomic status, and access to care generally only slightly attenuated the observed associations, particularly among older individuals; adjustment for cardiovascular disease, arthritis, and cancer attenuated most associations such that statistical significance was no longer achieved.

Limitations—Inability to establish causality and possible unmeasured confounding.

Conclusion—CKD is associated with higher prevalence of disability in the United States. Age and other comorbid conditions account for most, but not all, of this association.

Index Words

chronic kidney disease; disability; activities of daily living; limitations; employment; physical functioning; cognitive functioning

Chronic kidney disease (CKD), even prior to end-stage renal disease (ESRD), is associated with significant changes in physical and mental functioning that could lead to poor outcomes, including disability. Previous reports have shown that physical functioning, both laboratory-measured and self-reported, is substantially reduced in the setting of CKD (1) and ESRD (2). Similarly, frailty has been shown to be associated with earlier-stage CKD in an elderly prospective community-based cohort (3) and in the U.S. adult population (4). Decreased cognitive function, which can lead to decreased cognitive performance (5,6) and disability in terms of work and activities of daily living, has also been well-described in CKD (6–10). However, the degree to which these deficits in functioning contribute to limitations and difficulties in everyday activities, or the degree of disability, has been less well-described in the CKD setting.

The USRDS, as part of its Comprehensive Dialysis Study (11), reported that only about 25% of ESRD patients <55 years old in the United States reported being able to work for pay and that approximately 80% of the same patients received or had applied for Social Security disability benefits (12). It has also been reported that ESRD results in substantial nonmedical costs for employers, including disability insurance costs estimated at \$32,000 per ESRD-related disability (13). Data on disability in earlier stages of CKD, however, are scarce and conflicting. Shlipak et al. (3) found that frailty but not disability was associated with chronic renal insufficiency in elderly persons. However, it has been estimated that disability and absenteeism account for about 25% of the total health-related costs of CKD (14,15).

In this study, we aimed to describe and compare the prevalence of a comprehensive range of self-reported disabilities among community-dwelling adults aged 20 or more years, with and without CKD, using data from the National Health and Nutrition Examination Survey (NHANES) 1999–2006. Additionally, we aimed to examine the factors that modify the association of disability with CKD status in older and younger adults.

Methods

Study Design

The NHANES is conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention. The survey consists of a standardized in-home interview, followed by a physical examination and blood and urine collection at a mobile examination center. Data from NHANES consist of representative samples of non-institutionalized U.S. civilian residents and are released every 2 years (16). All participants

give written informed consent. The protocol was approved by the NCHS Research Ethics Review Board.

Here, we combined data from the 1999–2000, 2001–2002, 2003–2004, and 2005–2006 NHANES. Among the adult participants (≥ 20 years) with both interview and mobile examination center data ($N=18,986$), 2,977 were excluded due to no available serum creatinine and urine albumin and creatinine measurements ($n=2,924$), non-response to the adult physical functioning questionnaire ($n=19$), estimated glomerular filtration rate (eGFR) <15 ml/min/1.73 m² ($n=32$), or pregnancy ($n=0$, after other exclusions), leaving a total of 16,011 adult participants.

Measurements

As part of the home interview portion of NHANES, participants were asked questions pertaining to functional limitations. Interviewers administered the questions via the Computer-Assisted Personal Interviewing (CAPI) system. Adults aged ≥ 20 years were asked about general functional limitations caused by a long-term physical, mental or emotional problem or illness (not including temporary conditions; Table 1). Additionally in this questionnaire, participants were asked about difficulty performing activities in five categories: activities of daily living (ADL), instrumental ADL, leisure and social activities; lower extremity mobility; and general physical activity (Table 1).

Self-reported information on demographics (age, gender, race/ethnicity), socioeconomic status and healthcare access (education, insurance, income, routine source of care), health conditions [self-reported diagnosis of diabetes, hypertension, cardiovascular disease (CVD), cancer, and arthritis], and depression screening was also obtained during the interview portions of the health examinations. Prescription medications were recorded by the interviewer from the bottles provided by the participant. Height and weight, used to calculate body mass index (BMI, in kg/m²), systolic and diastolic blood pressure (average of at least three auscultatory measurements), and ankle-brachial index were measured in the mobile examination center. Serum and urine samples were collected during this exam. Serum creatinine was measured by the modified kinetic method of Jaffe using different analyzers in different survey years. Random spot urine samples were obtained, and urine albumin and creatinine were measured using frozen specimens. Urine albumin was measured using solid-phase fluorescence immunoassay; urine creatinine was measured using the modified Jaffe kinetic method in the same laboratory. Hemoglobinometry was performed with a single-beam photometer. C-reactive protein was measured by latex-enhanced nephelometry.

Definitions

Disability—General functional limitations in ability to work, in type or amount of work performed, in walking, and by confusion were defined by answers of “yes” to the respective functional limitation questions. Difficulties in activities domains (ADL, instrumental ADL, leisure and social activities, lower extremity mobility, and general physical activity) were defined by a report of “some” or greater difficulty in at least one of the activities within the domain in question.

CKD—CKD was defined as either reduced kidney function or elevated albuminuria. Estimated GFR (eGFR) was calculated according to the IDMS-traceable 4-variable MDRD Study equation for calibrated creatinine: $eGFR = 175 \times [(\text{calibrated serum creatinine in mg/dl})^{-1.154}] \times \text{age}^{-0.203} \times (0.742 \text{ if female}) \times (1.210 \text{ if African-American})$ (17). As specified in NHANES documentation (18), we corrected serum creatinine levels in the 1999–2000 and 2005–2006 surveys. Albuminuria was defined by a urinary albumin-creatinine ratio of at

least 30 mg/g (microalbuminuria). Because urine albumin measurements in NHANES were cross-sectional, we did not have data on persistent albuminuria, and the definitions of stages (19) were therefore modified as: no CKD, eGFR ≥ 60 ml/min/1.73 m² and no albuminuria on single measurement; stages 1 and 2, eGFR ≥ 60 ml/min/1.73 m² and presence of albuminuria on single measurement (evidence of kidney damage); and stages 3 and 4, eGFR 15–59 ml/min/1.73 m² (evidence of reduced kidney function with or without kidney damage).

Other Definitions—Self-reported diabetes, CVD, cancer, and arthritis were defined by answers of “yes” to the question, “Have you ever been told by a doctor or other health professional that you have [*disease or condition*]?” Self-reported CVD was defined by an answer of “yes” to any of: coronary artery disease, angina, myocardial infarction, stroke, or congestive heart failure. Hypertension was defined by self-report (as above) or by measured systolic or diastolic blood pressure ≥ 140 or ≥ 90 mmHg, respectively. Obesity was defined by a measured BMI ≥ 30 kg/m². Anemia was defined by a hemoglobin < 12 (females) or < 13 (males) g/dl, and inflammation was defined by a C-reactive protein level ≥ 1 mg/dl. Physical activity was defined by whether participants self-reported activity levels that were higher, the same, or less than those of their peers. Depression (2005–2006 only) was defined as a tentative diagnosis from the Patient Health Questionnaire-9 (20). Peripheral vascular disease was defined by an ankle-brachial index of < 0.9 (left or right, measured on persons aged ≥ 40 years; 1999–2004 only).

Statistical Methods

Selected characteristics were compared overall and within age groups (20–64 and ≥ 65 years) across CKD (no CKD, stages 1 and 2, and stages 3 and 4) using χ^2 and ANOVA for categorical and continuous variables, respectively. Excluded participants were also compared to those included in the study by these characteristics. Unadjusted and adjusted prevalence of disability was calculated by age and CKD, and variance of proportions was estimated with Taylor series linearization. Adjusted prevalence estimates were estimated using marginal probabilities from multivariable logistic regression models (21). Adjustment variables, including demographics (age, gender, and race/ethnicity), socioeconomic status and healthcare access (education, insurance, income, and routine site for healthcare), and clinical conditions (diabetes, hypertension, obesity, cardiovascular disease, cancer, and arthritis), were chosen based on their demonstrated strong association with both disability and CKD or *a priori* hypothesis that they were confounding factors in the association of disability with CKD. Sensitivity analyses with further covariates, with CKD defined by GFR estimated using the Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation (22) with eGFR and albuminuria, and with different definitions of disability, were performed. All analyses were performed using the `svy` commands in Stata v. 11.0 (www.stata.com) to account for appropriate study design weights (23), strata, and primary sampling units.

Results

Population Characteristics by CKD and Age

Tables 2–3 shows that, overall, those with CKD were older and more likely to be female than those with no CKD. The use of the CKD-EPI equation resulted in a lower prevalence of CKD stage 3–4 in participants aged < 65 years (Table 2) and also in women and non-Hispanic whites. However, despite these differences in prevalence, the associations of population characteristics with CKD severity were similar using the CKD-EPI equation. Those with CKD stages 1 and 2 were more likely to be non-Hispanic black, to not have a high school diploma, and to report less physical activity than those with either no CKD or CKD stages 3 and 4. Among older (≥ 65 years; Table 3) adults, those with CKD were more

likely to have lower income than those without CKD. Likelihood of insured status and a reported routine site for healthcare were higher in CKD. Regardless of age group, those with CKD were more likely to report diabetes, CVD, arthritis, and cancer and to have hypertension, anemia, and inflammation.

When characteristics were compared among included ($n=16,011$) and excluded ($n=2,975$) participants, those excluded from the study were younger (41.9 vs. 50.8 years) and less likely to be male (24.1% vs. 51.9%) or white (45.1% vs. 50.9%) or to have high income (18.4% vs. 20.9%), diabetes (8.2% vs. 10.3%), or hypertension, 43.4% vs. 49.7%), compared to those who were included in the study ($P<0.001$ for all).

Prevalence of Disability by CKD

We found that crude prevalence of disability (see Table 4) was high among both younger (20–64 years) and older (≥ 65 years) adults and was statistically significantly higher among those with CKD. Age-adjusted estimates among those with CKD relative to those without CKD show that general functional limitations (Figure 1A) and difficulties in activities (Figure 1B) are quite common in the population, even among younger adults with no CKD (4–20%). Within age groups, age-adjusted estimates were greater with CKD, with, in some cases, up to 2–3 times the prevalence of disability among those with CKD (either stages 1 and 2 or stages 3 and 4), relative to no CKD. Additionally, regardless of the functional limitation or difficulty in activity, those who were older (≥ 65 years) had greater levels of reported disability, up to 3-fold over their younger counterparts with the same category of CKD (*e.g.*, lower extremity mobility and general physical activity; Figure 1B). Results were similar with CKD defined by the CKD-EPI equation (Figure S1; provided as online supplementary material).

Since there are other potential confounders of the association between disability and CKD, we examined multivariable models adjusting for demographics, socioeconomic status and healthcare access, and other clinical conditions (Table 4), in order to assess what factors might account for the observed associations. We found that adjustment for neither demographics nor socioeconomic status and health care access changed any of the observed statistically significant associations between CKD and measures of disability. However, after adjusting for clinical conditions that frequently coexist with CKD (diabetes, hypertension, CVD, obesity, arthritis and cancer) and that may also lead to substantial disability, we found that many of the associations lost statistical significance, although the pattern of greater disability with CKD, generally persisted among older, but not younger, adults. With full adjustment, reported limitation in type or amount of work ($P=0.003$ and 0.08) and reported difficulties with leisure and social activities ($P=0.02$ and 0.02) remained associated with CKD among older adults (Table 4); walking remained associated in younger adults. Results were similar with CKD defined by the CKD-EPI equation (Table S1).

Overall, sensitivity analyses with further possible confounders of the association of disability with CKD, including total number of comorbid conditions, total number of reported prescription medications, physical activity, inflammation, anemia, depression, and peripheral vascular disease, showed similar results (Table S2). Total number of comorbid conditions resulted in a similar attenuation as that with individual conditions. Patterns of loss of statistical significance (but similar estimates) observed, as with prescription medications and depression, may indicate possible mechanisms or may be due to loss of power in the subsamples with available data (*e.g.*, depression attenuating the association of disability in CKD stages 3 and 4 in younger individuals; Table S2).

In further sensitivity analyses (Table S3), albuminuria and eGFR were independently associated with disability as measured by difficulty with ADL, but the association of

albuminuria with disability appeared stronger for both younger and older individuals. Using more stringent definitions of disability, the associations of CKD with disability were no longer significant, likely at least partially due to small numbers of individuals with more severe disability. [ND1]

Prevalence of Disability in CKD Compared to Other Conditions

The adjusted prevalence of disability in CKD was similar to that in other self-reported conditions, including hypertension, cancer, CVD, diabetes, and obesity for most measures of disability. For example, the age-, gender- and race/ethnicity-adjusted prevalence of reported difficulty with ADL among those who had CKD who were aged ≥ 65 years was similar to the prevalence among those with other self-reported conditions including hypertension and cancer (Figure 2A); even after adjustment for the other conditions, prevalence was similar for CKD and the other conditions (data not shown). It should be noted that these conditions are frequently comorbid with CKD—particularly diabetes, hypertension, and CVD—and these other conditions also increase with age. The substantial overlap shown in Figure 2B shows that most individuals with CKD and disability in terms of ADL have multiple conditions that require treatment. Results were similar when CKD severity was defined by CKD-EPI (Figure S2).

Discussion

We found that CKD is associated with higher prevalence of disability across many measures of disability, including limitations in working, walking, and cognition and difficulties with ADL, instrumental ADL, and leisure and social activities, which were mostly, but not completely, attenuated by age and other comorbid conditions. Additionally, the associations differed by age: CKD was no longer statistically significantly associated with disability in younger adults after adjustment for comorbid conditions, whereas some associations among older adults generally remained robust to this adjustment. Overall, rates of disability were high and were similar to those seen in self-reported cancer, hypertension, CVD, obesity, and arthritis, even after adjustment for these comorbid conditions.

Disability is high in ESRD. Particularly with regard to limitations in ability to work, only ~15–25%, depending on age, of U.S. ESRD patients beginning dialysis treatment in 2005–2007 reported being able to work for pay and ~80% of the same patients received or had applied for Social Security disability benefits; in the year prior to starting dialysis, only ~50% of younger adults were working (12). However, progression of earlier-stage CKD to ESRD, if it occurs at all, can be quite slow. Thus, on the population level, it may be even more important to determine the burden of disability among the estimated 26 million adults estimated to have earlier-stage CKD in the United States (24). Although previous studies have examined particular aspects of disability, such as difficulties with ADL among an older community-dwelling cohort (3), the national estimates presented here include a wide range of disabilities related not only to work but to other aspects of everyday living and provide a comprehensive snapshot of disability associated with CKD in the United States.

The prevalence of disability associated with CKD differed substantially by measure. It has been shown previously that the type of disease may determine the type of disability; *e.g.*, arthritis may be associated with greater limitations in mobility, while CVD may be associated with greater limitations in activities requiring aerobic capacity (25). However, CKD is a disease with many manifestations—independent of associated diabetes, hypertension, or CVD—such as anemia, bone mineral metabolism, and uremia (26), so a single effect of CKD on disability is unlikely. Indeed, we found that CKD was associated with higher prevalence of a wide range of disabilities, particularly those disabilities affected

by lower functioning in both mental and physical domains, likely due to CKD manifestations and the various conditions that are frequently comorbid with CKD.

We found that younger adults generally had lower levels of disability and that the association of disability with CKD was generally attributable to comorbid conditions, prescription medications, and, possibly, associated depression (in stages 3 and 4). Older adults with CKD had higher rates of disability overall and the associations of CKD and disability were not as attenuated by comorbidity, prescription medications, or depression, suggesting that CKD exerts a stronger independent effect on disability in these individuals. For both age groups, disability was often more strongly associated with CKD in stages 1 and 2 than stages 3 and 4 after adjustment, which may be due to the increasing effects of comorbidity (and associated treatments) as CKD progresses.

There are several limitations to this study. Foremost, the cross-sectional design of this study does not allow us to establish causation since disability may be caused by CKD. However, the results do provide some evidence for causality: the graded association of CKD with disability for some measures; the magnitude of the association, even after the adjustment for other conditions that are likely associated with disability; and strong biological plausibility, in that the many pathophysiological manifestations of CKD are likely to cause mental and physical declines, leading to limitations in working, physical activities, and ADL. A second limitation is that, although sample weighting was used to estimate population prevalence, there may still be selection bias due to inclusion criteria, in that those completing the questionnaire or meeting the inclusion requirements were older and sicker than those excluded. Thus, our rates of both CKD and disability may be higher than those found in the general population. Prescription medications were self-reported and over-the-counter medications were not included. Finally, disability and comorbid diseases were both self-reported, and for the items regarding limitations only yes/no responses (versus graded or continuous responses) were recorded. Disability has a subjective component (in that a person who feels unable to perform a task will not perform the task, and thus is disabled), so self-report is an important way to measure disability. Diseases and conditions that are self-reported are likely to be under-reported; however, such misclassification would likely bias our results toward the null. Similarly, although some misclassification of CKD by single measurement of albuminuria and/or error in GFR estimation is likely, the association between CKD and disability remained robust to various definitions.

In summary, both mild and moderate CKD are associated with higher prevalence of disability in the United States, and age and other comorbid conditions account for some, but not all, of this association, particularly among older adults. The burden of disability in pre-ESRD CKD is high, and CKD is associated with disability across a wide range of measures, including activities that require both mental and physical functioning. Future work is needed to establish possible causes of and interventions to limit CKD-associated disability.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Age-adjusted prevalence of disability, as measured by self-report of general limitations (A) or of at least some difficulty in performing at least one activity in a domain (B), by CKD status, NHANES 1999–2006.

*P<0.05; **P<0.001 vs. no CKD. ADL, activities of daily living (getting in and out of bed, using fork/knife/cup [eating], dressing oneself); IADL, instrumental activities of daily living (managing money, house chores, preparing meals); LSA, leisure and social activities (going to the movies, attending social event, leisure activity at home); LEM, lower extremity mobility (walking ¼ mile, walking up to 10 steps, stooping/kneeling/crouching, walking between rooms on same floor, standing up from armless chair); GPA, general physical activity (lifting or carrying heavy objects, reaching up overhead, grasping/holding small objects, standing for long periods, sitting for long periods).

Figure 2.

Age-, gender- and race/ethnicity-adjusted* prevalence of reported difficulty with activities of daily living (ADL; getting in and out of bed, using fork/knife/cup [eating], dressing oneself) among adults with CKD and other self-reported conditions. *CVD*, cardiovascular disease.

A. Prevalence of reported difficulty with ADL among U.S. adults with various conditions.

B. Overlap of CKD with comorbid conditions for reported difficulty with ADL.

Table 1

Survey items pertaining to functional limitations and disability

Measure of disability	Survey item(s)	Possible responses *
Limitations		
Ability to work	"Does a physical, mental or emotional problem now keep you from working at a job or business?"	"yes", "no"
Type or amount of work	"Are you limited in the kind or amount of work you can do because of a physical, mental or emotional problem?"	"yes", "no"
Walking	"Because of a health problem, do you have difficulty walking without using any special equipment?"	"yes", "no"
Confusion/memory	"Are you limited in any way because of difficulty remembering or because you experience periods of confusion?"	"yes", "no"
Difficulties		
ADL	"By yourself and without using any special equipment, how much difficulty do you have..." <ul style="list-style-type: none"> • getting in and out of bed • eating • dressing yourself 	"no difficulty," "some difficulty," "much difficulty," "unable to do," "do not do this activity"
IADL	"By yourself and without using any special equipment, how much difficulty do you have..." <ul style="list-style-type: none"> • managing money • performing house chores • preparing meals 	"no difficulty," "some difficulty," "much difficulty," "unable to do," "do not do this activity"
LSA	"By yourself and without using any special equipment, how much difficulty do you have..." <ul style="list-style-type: none"> • going to the movies • attending social events • performing leisure activity at home" 	"no difficulty," "some difficulty," "much difficulty," "unable to do," "do not do this activity"
LEM	"By yourself and without using any special equipment, how much difficulty do you have..." <ul style="list-style-type: none"> • walking ¼ mile • walking up to 10 steps • stooping/kneeling/crouching • walking between rooms on same floor" • standing up from an armless chair" 	"no difficulty," "some difficulty," "much difficulty," "unable to do," "do not do this activity"
GPA	"By yourself and without using any special equipment, how much difficulty do you have..." <ul style="list-style-type: none"> • lifting or carrying heavy objects • reaching up overhead • grasping/holding small objects • standing for long periods 	"no difficulty," "some difficulty," "much difficulty," "unable to do," "do not do this activity"

Measure of disability	Survey item(s)	Possible responses*
	<ul style="list-style-type: none"> sitting for long periods” 	

ADL, activities of daily living; IADL instrumental ADL; LSA, leisure and social activities; LEM, lower extremity mobility; and GPA, general physical activity.

* Responses of “don’t know” or “refused,” were indicated by fewer <1% of respondents to any item listed and were set to missing in analyses. “Do not do this activity” was introduced as an option in the 2003–2004 and 2005–2006 surveys only; thus these responses were also set to missing. Among the participants in these survey years only, <1% chose this response for any of the difficulty items, except: managing money (1.5%), preparing meals (1.5%), doing house chores (1.4%), and attending social activities (1.3%),

Table 2

Population characteristics by CKD status for participants 20–64 years of age [ND2] [ND3] [ND4] [ND5]

Characteristic	CKD defined by MDRD Study*			P**	CKD defined by CKD-EPI*			P**
	No CKD (n=10,371)	CKD 1-2 (n=880)	CKD 3-4 (n=375)		No CKD (n=10,511)	CKD 1-2 (n=903)	CKD 3-4 (n=212)	
Total % in category	90.5 (89.7–91.2)	6.3 (5.7–6.8)	3.3 (2.8–3.8)		92.0 (91.3–92.5)	6.4 (5.9–7.0)	1.7 (1.4–2.0)	
Demographics								
Mean age, years	40.5 (40.1–41.0)	43.5 (42.4–44.6)	53.6 (52.7–54.6)	<0.001	40.7 (40.3–41.1)	43.7 (42.6–44.8)	55.0 (53.7–56.2)	<0.001
Gender				<0.001				0.02
% male	52.9 (52.0–53.7)	47.8 (44.1–51.5)	38.9 (33.3–44.9)		52.5 (51.7–53.4)	47.8 (44.2–51.4)	45.0 (36.7–53.6)	
% female	47.1 (46.3–48.0)	52.2 (48.5–55.9)	61.1 (55.1–66.7)		47.5 (46.7–48.3)	52.2 (48.6–55.8)	55.0 (46.4–63.4)	
Race/ethnicity**				<0.001				<0.001
% non-Hispanic white	70.7 (67.7–73.5)	55.8 (50.7–60.7)	80.2 (75.7–84.0)		70.9 (68.0–73.7)	56.3 (51.2–61.2)	74.2 (67.6–79.8)	
% non-Hispanic black	10.8 (9.1–12.7)	16.3 (13.2–20.0)	8.0 (5.9–10.7)		10.6 (9.0–12.5)	16.0 (12.9–19.7)	13.3 (9.4–18.4)	
% Mexican-American	8.3 (7.0–9.8)	10.7 (8.3–13.8)	2.9 (1.8–4.6)		8.2 (6.9–9.7)	10.7 (8.3–13.8)	2.5 (1.4–4.5)	
Socioeconomic Status and Healthcare Access								
Education				<0.001				<0.001
% <high school	17.0 (15.8–18.3)	25.1 (21.9–28.6)	16.8 (12.2–22.6)		16.9 (15.7–18.2)	24.8 (21.6–28.2)	22.3 (16.1–29.9)	
% high school+	83.0 (81.8–84.2)	75.0 (71.5–78.1)	83.2 (81.3–83.7)		83.1 (81.8–84.3)	75.2 (71.8–78.4)	77.7 (70.1–83.9)	
Household Income				<0.001				<0.001
% <\$20,000	14.2 (13.1–15.4)	23.2 (19.4–27.4)	18.0 (14.2–22.5)		14.2 (13.1–15.4)	23.4 (19.6–27.6)	19.7 (14.7–25.9)	
% \$20–44,999	27.3 (25.4–29.3)	32.0 (28.0–36.3)	27.2 (21.8–33.7)		27.3 (25.4–29.3)	31.9 (27.9–36.2)	27.1 (19.5–36.2)	
% \$45–74,999	26.3 (24.9–27.8)	21.9 (18.0–26.5)	29.5 (24.0–35.7)		26.3 (24.9–27.8)	22.1 (18.3–26.5)	31.3 (23.7–40.1)	
% \$75,000+	32.2 (29.5–35.0)	22.9 (18.6–27.9)	25.4 (18.4–34.0)		32.2 (29.4–35.0)	22.6 (18.3–27.6)	21.9 (14.0–32.7)	
Insurance				<0.001				0.07
% not insured	21.7 (20.1–23.3)	21.0 (17.7–24.8)	12.1 (8.4–17.1)		21.5 (20.0–23.2)	20.6 (17.4–24.2)	13.4 (8.1–21.5)	
% insured	78.3 (76.7–79.9)	79.0 (75.3–82.3)	87.9 (82.9–91.6)		78.5 (76.9–80.1)	79.4 (75.8–82.6)	86.6 (78.5–92.0)	
Routine site for healthcare				<0.001				0.001
% no	18.1 (16.9–19.3)	14.8 (11.9–18.3)	7.1 (4.0–12.3)		17.9 (16.8–19.1)	14.5 (11.6–17.8)	6.3 (3.1–12.5)	
% yes	81.9 (80.7–83.1)	85.2 (81.7–88.1)	92.9 (87.7–96.0)		82.1 (80.9–83.2)	85.5 (82.2–88.4)	93.7 (87.5–96.9)	

Characteristic	CKD defined by MDRD Study [*]			CKD defined by CKD-EPI [*]			P ^{**}
	No CKD (n=10,371)	CKD 1–2 (n=880)	CKD 3–4 (n=375)	No CKD (n=10,511)	CKD 1–2 (n=903)	CKD 3–4 (n=212)	
Clinical Status							
Smoking				0.02			0.02
% every day	23.4 (21.9–25.0)	27.4 (24.0–31.2)	17.7 (12.7–24.1)	23.4 (21.9–25.0)	27.0 (23.6–30.7)	13.9 (8.1–22.9)	
% sometimes/not at all	76.6 (75.0–78.1)	72.6 (68.8–76.0)	82.4 (75.9–87.4)	69.4 (67.8–71.0)	73.0 (69.3–76.4)	86.1 (77.1–91.9)	
Physical activity				0.04			0.1
% more/same as peers	55.6 (54.3–57.0)	59.1 (55.7–62.4)	61.8 (55.8–67.4)	55.7 (54.3–57.10)	59.4 (56.0–62.7)	62.4 (52.5–71.3)	
% less than peers	44.4 (43.0–45.7)	40.9 (37.8–44.3)	38.2 (32.6–44.2)	44.3 (42.9–45.7)	40.6 (37.3–44.0)	37.6 (28.7–47.5)	
BMI				<0.001			<0.001
% ≥30 kg/m ²	30.6 (29.0–32.2)	47.4 (42.5–52.4)	39.8 (34.5–45.5)	30.6 (29.0–32.2)	47.6 (42.7–52.5)	46.2 (38.0–54.6)	
% <30 kg/m ²	69.4 (67.8–71.0)	52.6 (47.6–57.5)	60.2 (54.5–65.6)	69.4 (67.8–71.0)	52.4 (47.5–57.3)	53.8 (45.4–62.0)	
Diabetes ^a				<0.001			<0.001
% yes	4.0 (3.6–4.4)	21.6 (18.7–24.9)	15.9 (11.7–21.3)	4.1 (3.6–4.5)	21.7 (18.8–25.0)	21.7 (15.5–29.5)	
% no	96.0 (95.6–96.4)	78.4 (75.1–81.3)	84.1 (78.7–88.3)	95.9 (95.5–96.4)	78.3 (75.0–81.2)	78.3 (70.6–84.5)	
HTN ^d				<0.001			<0.001
% yes	33.8 (32.0–35.7)	58.7 (54.0–63.3)	64.1 (57.1–70.6)	34.1 (32.3–35.9)	59.2 (54.5–63.7)	75.5 (66.1–83.0)	
% no	66.2 (64.3–68.0)	41.3 (36.7–46.0)	35.9 (29.4–42.9)	65.9 (64.1–67.7)	40.8 (36.3–45.5)	24.5 (17.0–34.0)	
CVD ^a				<0.001			<0.001
% yes	4.0 (3.5–4.5)	8.0 (6.3–10.3)	19.5 (15.1–24.6)	4.1 (3.6–4.7)	8.7 (6.8–11.2)	24.2 (17.9–31.9)	
% no	96.0 (95.5–96.5)	92.0 (89.7–93.7)	80.5 (75.4–84.9)	95.9 (95.3–96.4)	91.3 (88.8–93.3)	75.8 (68.1–82.1)	
Arthritis ^a				<0.001			<0.001
% yes	16.4 (15.3–17.6)	23.9 (20.7–27.5)	39.3 (33.0–46.0)	16.7 (15.6–17.9)	24.3 (21.2–27.7)	42.6 (34.1–51.6)	
% no	83.6 (82.4–84.7)	76.1 (72.5–79.3)	60.7 (54.0–67.0)	83.3 (82.1–84.4)	75.7 (72.3–78.8)	57.4 (48.4–65.9)	
Cancer ^a				<0.001			0.03
% yes	4.7 (4.2–5.4)	5.6 (4.0–7.8)	11.4 (8.5–15.2)	4.9 (4.4–5.5)	5.5 (3.9–7.8)	9.3 (6.3–13.6)	
% no	95.3 (94.7–95.8)	94.4 (92.2–96.1)	88.6 (84.8–91.5)	95.1 (94.5–95.6)	94.5 (92.2–96.1)	90.7 (86.4–93.7)	
Anemia ^b				<0.001			<0.001

Characteristic	CKD defined by MDRD Study*			CKD defined by CKD-EPI*			P**
	No CKD (n=10,371)	CKD 1-2 (n=880)	CKD 3-4 (n=375)	No CKD (n=10,511)	CKD 1-2 (n=903)	CKD 3-4 (n=212)	
% yes	3.7 (3.2-4.3)	6.4 (4.7-8.7)	8.9 (6.1-12.7)	3.8 (3.3-4.3)	6.4 (4.7-8.6)	12.6 (8.6-18.1)	
% no	96.3 (95.7-96.8)	93.6 (91.4-95.3)	91.1 (87.3-93.9)	96.2 (95.7-96.7)	93.6 (91.4-95.3)	87.4 (81.9-91.4)	
Inflammation ^c							<0.001
% yes	8.6 (7.9-9.4)	14.5 (11.7-17.9)	16.2 (12.8-20.2)	8.7 (8.0-9.5)	15.0 (12.1-18.6)	17.0 (12.5-22.7)	
% no	91.4 (90.6-92.1)	85.5 (82.1-88.3)	83.8 (79.8-87.2)	91.3 (90.6-92.0)	85.0 (81.5-87.9)	83.0 (77.3-87.5)	

Study population comprises participants of the stated age in NHANES (National Health and Nutrition Examination Survey) 1999-2006. Values shown are mean or percentage; 95% confidence intervals are shown in parentheses.

* There was 98.3% agreement in CKD category between the MDRD Study and CKD-EPI equations. Compared to the MDRD Study equation, 245 individuals (1.6%) with no CKD, stage 1 or 2, or stage 3 or 4 CKD were reclassified into another stage using the CKD-EPI equation: 172 individuals with CKD stage 3 or 4 by the MDRD Study Equation were reclassified as no CKD and 34 were reclassified as stage 1 or 2 with the CKD-EPI equation; and 17 individuals with stage 1 or 2 and 39 individuals with no CKD by the MDRD Study equation were reclassified as CKD stage 3 or 4 by the CKD-EPI equation.

** By chi-square (categorical variables) and ANOVA (continuous variables) tests, within equation.

*** Other race/ethnicity not shown due to small sample sizes but individuals in category are included in all analyses.

^a self-reported

^b Anemia defined as hemoglobin <12 g/dl for females and <13 g/dl for males.

^c Inflammation defined as C-reactive protein ≥ 1.0 mg/dl.

^d self-reported or measured BP 140+/90+

CKD, chronic kidney disease; BMI, body mass index, CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; MDRD, Modification of Diet in Renal Disease; CVD, cardiovascular disease; HTN, hypertension

Table 3

Population characteristics by CKD status for participants 65 years of age and older

Characteristic	CKD defined by MDRD Study*			P**	CKD defined by CKD-EPI*			P**
	No CKD (n=2,432)	CKD 1-2 (n=594)	CKD 3-4 (n=1,359)		No CKD (n=2,425)	CKD 1-2 (n=588)	CKD 3-4 (n=1,375)	
Total % in category	57.0 (55.2-58.7)	11.6 (10.5-12.7)	31.5 (29.8-33.2)		57.5 (55.8-59.2)	11.6 (10.5-12.8)	30.9 (29.1-32.7)	
Demographics								
Mean age, years	72.3 (71.9-72.6)	74.6 (74.1-75.2)	76.6 (76.1-77.1)	<0.001	72.1 (71.8-72.4)	74.4 (73.8-75.0)	77.0 (76.5-77.5)	<0.001
Gender				<0.001				0.02
% male	44.9 (42.6-47.2)	48.0 (42.5-53.6)	37.9 (35.4-40.4)		44.2 (42.0-46.4)	46.8 (41.5-52.3)	39.4 (36.6-42.3)	
% female	55.1 (52.8-57.4)	52.0 (46.4-57.5)	62.1 (59.6-64.6)		55.8 (53.6-58.0)	53.2 (47.8-58.5)	60.6 (57.7-63.4)	
Race/ethnicity**				<0.001				0.006
% non-Hispanic white	82.9 (79.6-85.8)	79.3 (74.0-83.7)	87.4 (84.2-90.0)		83.4 (80.0-86.3)	80.3 (75.1-84.6)	86.2 (82.9-89.0)	
% non-Hispanic black	7.4 (5.9-9.1)	9.7 (7.2-12.9)	6.0 (4.6-7.8)		6.9 (5.5-8.6)	9.0 (6.6-12.2)	7.1 (5.5-9.1)	
% Mexican-American	3.4 (2.4-4.8)	4.4 (2.9-6.7)	1.5 (0.9-2.4)		3.4 (2.4-4.8)	4.4 (2.9-6.7)	1.5 (0.9-2.4)	
Socioeconomic Status and Healthcare Access								
Education				<0.001				<0.001
% <high school	26.3 (23.5-29.3)	40.3 (34.4-46.4)	33.8 (30.3-37.4)		25.8 (23.1-28.8)	39.0 (33.5-44.8)	35.3 (31.7-39.0)	
% high school+	73.7 (70.7-76.5)	59.7 (53.6-65.6)	66.2 (62.6-69.7)		74.2 (71.2-76.9)	61.0 (55.3-66.5)	64.8 (61.0-68.3)	
Household Income				<0.001				<0.001
% <\$20,000	26.9 (23.6-30.5)	37.5 (32.2-43.2)	36.2 (32.2-40.5)		26.8 (23.5-30.4)	38.1 (32.2-44.2)	36.3 (32.1-40.7)	
% \$20-44,999	41.2 (38.0-44.5)	36.9 (32.0-42.2)	37.7 (34.0-41.7)		41.2 (38.0-44.6)	36.6 (31.6-42.0)	37.8 (34.2-41.6)	
% \$45-74,999	19.4 (16.9-22.2)	17.8 (13.0-24.0)	16.3 (13.3-20.0)		19.4 (16.8-22.2)	17.4 (12.6-23.5)	16.6 (13.4-20.3)	
% \$75,000+	12.5 (10.0-15.4)	7.7 (5.0-11.8)	9.7 (7.5-12.4)		12.6 (10.1-15.6)	7.9 (5.1-12.1)	9.3 (7.3-11.8)	
Insurance				0.01				0.02
% not insured	1.3 (0.9-1.9)	2.0 (0.1-3.9)	0.4 (0.2-0.8)		1.3 (0.9, 1.9)	2.0 (1.0-3.9)	0.5 (0.2-0.9)	
% insured	98.7 (98.1-99.1)	98.1 (96.2-99.0)	99.6 (99.2-99.8)		98.7 (98.1-99.1)	98.0 (96.1-99.0)	99.5 (99.1-99.8)	
Routine site for healthcare				0.1				0.2
% no	3.1 (2.4-4.0)	2.5 (1.2-4.8)	1.9 (1.3-2.8)		3.1 (2.4-3.9)	2.4 (1.2-4.7)	2.0 (1.4-2.9)	
% yes	96.9 (96.0-97.6)	97.5 (95.2-98.8)	98.1 (97.3-98.7)		96.9 (96.1-97.6)	97.6 (95.3-98.8)	98.0 (97.1-98.6)	

Characteristic	CKD defined by MDRD Study*				CKD defined by CKD-EPI*			
	No CKD (n=2,432)	CKD 1-2 (n=594)	CKD 3-4 (n=1,359)	P**	No CKD (n=2,425)	CKD 1-2 (n=588)	CKD 3-4 (n=1,375)	P**
Clinical Status								
Smoking				<0.001				<0.001
% every day	8.1 (7.0-9.3)	13.3 (10.1-17.2)	5.9 (4.4-7.8)		8.0 (7.0-9.2)	13.4 (10.3-17.3)	5.9 (4.4-7.8)	
% sometimes/not at all	91.9 (90.7-93.0)	86.7 (82.9-89.9)	94.1 (92.2-95.6)		92.0 (90.9-93.0)	86.6 (82.7-89.7)	94.2 (92.2-95.7)	
Physical activity				0.06				0.1
% more/same as peers	65.1 (62.5-67.6)	58.9 (54.2-63.4)	65.5 (62.3-68.6)		64.9 (62.3-67.5)	59.9 (55.1-64.4)	65.5 (62.2-68.6)	
% less than peers	34.9 (32.4-37.6)	41.1 (36.6-45.8)	34.5 (31.4-37.7)		35.1 (32.5-37.8)	40.1 (35.6-44.9)	34.5 (31.4-37.8)	
BMI				0.2				0.1
% ≥30 kg/m ²	28.8 (26.8-30.9)	31.1 (26.9-35.8)	31.9 (28.9-35.0)		28.8 (26.8-30.8)	31.5 (27.3-36.0)	31.9 (29.0-35.0)	
% <30 kg/m ²	71.2 (69.1-73.2)	68.9 (64.3-73.1)	68.1 (65.0-71.1)		71.2 (69.2-73.2)	68.5 (64.0-72.7)	68.1 (65.0-71.0)	
Diabetes ^a				<0.001				<0.001
% yes	12.1 (10.5-13.9)	23.9 (19.8-28.5)	20.0 (16.9-23.6)		12.2 (10.6-13.9)	23.5 (19.4-28.2)	20.1 (17.1-23.5)	
% no	87.9 (86.1-89.5)	76.1 (71.5-80.2)	80.0 (76.4-83.1)		87.8 (86.1-89.4)	76.5 (71.8-80.6)	79.9 (76.5-82.9)	
HTN ^d				<0.001				<0.001
% yes	28.9 (26.3-31.7)	18.6 (14.8-23.2)	16.1 (13.9-18.6)		29.1 (26.5-32.0)	18.4 (14.5-23.1)	15.5 (13.4-17.8)	
% no	71.1 (68.3-73.7)	81.4 (76.9-85.3)	83.9 (81.4-86.1)		70.9 (68.1-73.5)	81.6 (76.7-85.5)	84.5 (82.2-86.6)	
CVD ^a				<0.001				<0.001
% yes	21.6 (19.4-23.9)	30.4 (25.4-35.8)	39.0 (35.6-42.4)		21.1 (19.0-23.5)	30.6 (25.7-35.9)	40.0 (36.6-43.6)	
% no	78.4 (76.1-80.6)	69.6 (64.2-74.6)	61.0 (57.6-64.4)		78.9 (76.5-81.1)	69.4 (64.1-74.3)	60.0 (56.4-63.4)	
Arthritis ^a				0.003				0.006
% yes	51.0 (48.6-53.5)	50.7 (46.4-55.1)	57.6 (54.4-60.7)		51.2 (48.8-53.5)	51.3 (46.9-55.7)	57.3 (54.1-60.4)	
% no	49.0 (46.5-51.4)	49.3 (45.0-53.6)	42.4 (39.3-45.7)		48.8 (46.5-51.2)	48.7 (44.3-53.1)	42.7 (39.6-45.9)	
Cancer ^a				0.03				0.03
% yes	21.6 (19.5-23.9)	23.2 (19.4-27.5)	26.2 (23.4-29.3)		21.5 (19.3-23.8)	23.7 (19.7-28.2)	26.4 (23.6-29.3)	
% no	78.4 (76.1-80.5)	76.8 (72.5-80.6)	73.8 (70.7-76.6)		78.5 (76.2-80.7)	76.3 (71.8-80.3)	73.7 (70.7-76.4)	
Anemia ^b				<0.001				<0.001

Characteristic	CKD defined by MDRD Study*				CKD defined by CKD-EPI*			
	No CKD (n=2,432)	CKD 1-2 (n=594)	CKD 3-4 (n=1,359)	P**	No CKD (n=2,425)	CKD 1-2 (n=588)	CKD 3-4 (n=1,375)	P**
% yes	5.7 (4.8-6.8)	8.0 (5.9-10.8)	16.3 (13.8-19.1)		5.4 (4.5-6.5)	7.9 (5.7-10.7)	17.1 (14.4-20.1)	
% no	94.3 (93.2-95.2)	92.0 (89.2-94.2)	83.7 (81.0-86.2)		94.6 (93.5-95.5)	92.1 (89.3-94.3)	83.0 (79.9-85.6)	
Inflammation ^c				0.003				0.006
% yes	9.5 (8.0-11.1)	12.0 (8.9-16.0)	13.8 (12.0-15.7)		9.5 (8.1-11.2)	12.5 (9.5-16.5)	13.6 (11.8-15.6)	
% no	90.5 (88.9-92.0)	88.0 (84.0-91.1)	86.2 (84.3-88.0)		90.5 (88.8-91.9)	87.5 (83.5-90.6)	86.5 (84.5-88.2)	

Study population comprises participants of the stated age in NHANES (National Health and Nutrition Examination Survey) 1999-2006.

* There was 98.3% agreement in CKD category between the MDRD Study and CKD-EPI equations. Compared to the MDRD Study equation, 245 individuals (1.6%) with no CKD, stage 1 or 2, or stage 3 or 4 CKD were reclassified into another stage using the CKD-EPI equation: 172 individuals with no CKD, stage 1 or 2, or stage 3 or 4 CKD were reclassified into another stage using the CKD-EPI equation; 172 individuals with CKD stage 3 or 4 by the MDRD Study Equation were reclassified as no CKD and 34 were reclassified as stage 1 or 2 with the CKD-EPI equation; and 17 individuals with stage 1 or 2 and 39 individuals with no CKD by the MDRD Study equation were reclassified as CKD stage 3 or 4 by the CKD-EPI equation.

** By chi-square (categorical variables) and ANOVA (continuous variables) tests, within equation.

*** Other race/ethnicity not shown due to small sample sizes but individuals in category are included in all analyses.

^a self-reported

^b Anemia defined as hemoglobin <12 g/dl for females and <13 g/dl for males.

^c Inflammation defined as C-reactive protein ≥1.0 mg/dl.

^d self-reported or measured BP 140+/90+

CKD, chronic kidney disease; BMI, body mass index, CKD-EPI, Chronic Kidney Disease Epidemiology Collaboration; MDRD, Modification of Diet in Renal Disease; CVD, cardiovascular disease; HTN, hypertension

Table 4

Prevalence of disability measures in US adults, by age and CKD status

	20–64 years of age			65+ years of age		
	No CKD	CKD 1–2	CKD 3–4	No CKD	CKD 1–2	CKD 3–4
Reported Limitations:						
In ability to work						
Unadjusted	8.1 (7.2–9.1) **	16.3 (13.7–19.3) **	21.4 (16.3–27.5) **	12.4 (10.6–14.4) **	21.1 (16.5–26.6) **	19.5 (16.4–23.0) **
+ Demographics	8.4 (7.4–9.3)	14.3 (11.9–16.8) **	14.4 (10.5–18.4) **	12.6 (10.7–14.4)	20.7 (15.7–25.7) *	19.2 (15.8–22.6) **
+ SES/access	8.5 (7.7–9.3)	11.9 (9.7–14.1) *	13.2 (9.1–17.3) *	13.0 (11.0–14.9)	20.9 (15.7–26.1) *	18.5 (15.0–22.0) *
+ Clinical conditions	8.7 (7.9–9.5)	9.4 (7.7–11.0)	9.6 (6.4–12.8)	13.3 (11.3–15.3)	18.1 (13.3–22.8)	16.0 (12.9–19.1)
In type or amount of work performed						
Unadjusted	19.8 (18.0–21.8) **	33.8 (29.5–38.3) **	44.3 (34.7–54.4) **	37.3 (33.5–41.4) **	54.9 (48.1–61.4) **	51.2 (46.6–55.7) **
+ Demographics	20.4 (18.6–22.2)	30.4 (26.1–34.8) **	31.4 (22.9–39.9) *	38.3 (34.5–42.2) **	54.5 (47.8–61.2) **	49.5 (44.4–54.6) **
+ SES/access	20.2 (18.5–21.9)	27.1 (22.6–31.5) *	28.7 (21.1–36.4) *	38.3 (34.6–42.0)	52.9 (45.7–60.1) *	48.1 (43.1–53.2) *
+ Clinical conditions	20.5 (18.8–22.4)	21.9 (18.4–25.5)	23.0 (15.9–30.0)	39.0 (35.5–42.4)	51.6 (44.9–58.2) *	43.7 (39.0–48.4) *
In walking						
Unadjusted	5.5 (4.8–6.4) **	12.4 (9.5–16.1) **	21.6 (16.0–28.6) **	15.3 (13.0–18.0) **	33.7 (28.1–39.9) **	27.0 (23.2–31.2) **
+ Demographics	5.8 (5.0–6.6)	10.4 (7.5–13.4) **	12.6 (8.3–16.9) **	16.9 (14.4–19.5)	32.4 (26.7–38.1) **	24.0 (20.6–27.4) *
+ SES/access	5.8 (5.1–6.5)	9.9 (6.9–12.9) *	11.4 (7.6–15.3) *	16.9 (14.3–19.4)	30.5 (24.5–36.4) **	23.2 (20.1–26.2) *
+ Clinical conditions	5.9 (5.3–6.5)	6.0 (4.0–8.0)	8.3 (5.7–10.8)	16.8 (14.3–19.3)	27.4 (22.2–32.5) **	19.5 (17.1–22.0)
By confusion						
Unadjusted	4.6 (4.1–5.2) **	7.5 (5.5–10.1) **	10.1 (6.8–14.7) **	11.1 (9.5–12.8) **	14.2 (11.6–17.1) **	18.5 (15.6–21.7) **
+ Demographics	4.7 (4.2–5.3)	6.7 (4.7–8.6) *	7.5 (4.6–10.4) *	12.2 (10.4–13.9)	13.4 (10.8–16.0)	16.3 (13.4–19.2) *
+ SES/access	4.8 (4.2–5.4)	5.9 (4.4–7.4)	6.2 (3.4–9.0)	12.3 (10.4–14.2)	14.0 (11.3–16.7)	16.4 (13.3–19.4) *
+ Clinical conditions	4.9 (4.3–5.4)	5.5 (3.6–6.7)	5.1 (2.7–7.5)	12.5 (10.5–14.4)	13.1 (10.1–16.0)	15.3 (12.4–18.1)
Reporting Difficulties:						
In ADL						

	20–64 years of age			65+ years of age		
	No CKD	CKD 1–2	CKD 3–4	No CKD	CKD 1–2	CKD 3–4
Unadjusted	6.6 (5.9–7.2) **	13.4 (11.0–16.2) **	18.6 (14.0–24.3) **	16.8 (15.0–18.7) **	25.1 (20.0–31.0) **	25.6 (23.6–27.7) **
+ Demographics	6.8 (6.2–7.5)	11.4 (9.1–13.7) **	11.0 (7.9–14.1) *	17.6 (15.7–19.5)	24.5 (19.2–29.8) *	24.0 (21.9–26.0) **
+ SES/access	7.0 (6.3–7.6)	9.9 (7.4–12.4) *	10.2 (6.9–13.6) *	17.8 (15.6–19.9)	24.4 (18.9–29.9) *	23.1 (21.0–25.2) *
+ Clinical conditions	7.0 (6.3–7.7)	7.7 (6.1–9.4)	7.8 (5.1–10.5)	18.2 (15.8–20.6)	22.4 (17.5–27.4)	20.2 (18.3–22.2)
In IADL						
Unadjusted	8.9 (8.2–9.8) **	17.2 (14.4–20.5) **	22.3 (17.3–28.3) **	23.4 (21.0–26.0) **	31.6 (26.8–36.7) **	36.3 (33.2–39.6) **
+ Demographics	9.2 (8.4–10.0)	15.3 (12.6–18.1) **	14.6 (10.8–18.3) *	24.7 (22.3–27.1)	31.5 (26.6–36.4) *	33.5 (30.4–36.7) **
+ SES/access	9.3 (8.6–10.1)	12.9 (10.0–15.9) *	13.7 (9.9–17.5) *	24.7 (22.5–27.0)	30.9 (25.8–36.1) *	32.3 (29.1–35.4) **
+ Clinical conditions	9.43 (8.7–10.1)	10.1 (8.0–12.3)	10.6 (7.7–13.5)	25.1 (22.8–27.3)	28.3 (23.8–32.8)	28.1 (25.2–31.0)
In LSA						
Unadjusted	6.5 (5.9–7.2) **	12.0 (9.6–14.9) **	19.3 (14.2–25.8) **	16.1 (14.1–18.2) **	26.2 (21.2–31.8) **	28.4 (25.2–31.8) **
+ Demographics	6.7 (6.1–7.4)	10.5 (8.3–12.8) *	12.0 (8.2–15.7) *	24.2 (19.8–28.5)	34.3 (27.2–41.4) *	37.6 (28.3–46.9) *
+ SES/access	6.9 (6.3–7.5)	8.8 (6.5–11.0)	10.9 (7.0–14.8) *	17.2 (15.1–19.3)	25.8 (20.1–31.5) *	25.2 (21.9–28.5) **
+ Clinical conditions	7.0 (6.4–7.7)	6.4 (4.9–8.0)	8.1 (5.3–10.9)	17.4 (15.5–19.3)	23.6 (18.5–28.7) *	21.5 (18.5–24.6) *
In LEM						
Unadjusted	13.3 (12.3–14.4) **	22.9 (20.1–26.0) **	34.5 (28.6–41.0) **	52.2 (49.5–54.9) **	62.7 (57.1–68.1) **	65.3 (62.4–68.1) **
+ Demographics	13.8 (12.8–14.9)	20.0 (17.2–22.6) **	19.7 (15.8–23.6) *	54.2 (51.6–56.8)	62.6 (57.1–68.1) *	62.0 (58.9–65.0) **
+ SES/access	14.1 (13.0–15.1)	17.7 (14.9–20.6) *	18.3 (14.3–22.3) *	54.5 (51.8–57.2)	63.6 (57.2–69.5) *	60.9 (57.7–64.1) *
+ Clinical conditions	14.3 (13.3–15.2)	14.0 (12.1–15.9)	14.7 (11.4–18.1)	55.2 (52.6–57.8)	60.8 (54.0–67.6)	56.5 (53.3–59.8)
In GPA						
Unadjusted	13.2 (12.2–14.3) **	22.1 (13.2–25.3) **	34.5 (28.8–40.6) **	49.8 (47.2–52.5) **	60.9 (55.2–66.4) **	63.4 (60.4–66.3) **
+ Demographics	13.7 (12.7–14.8)	19.5 (16.8–22.1) **	20.4 (16.4–24.4) **	51.7 (49.3–54.2)	60.9 (55.0–66.7) *	60.1 (57.4–63.1) **
+ SES/access	13.9 (12.8–15.0)	17.2 (14.2–20.2) *	19.4 (15.3–23.5) *	52.2 (49.4–54.9)	60.3 (54.0–66.6) *	58.9 (55.9–61.9) *
+ Clinical conditions	14.1 (13.0–15.1)	13.6 (11.6–15.6)	15.8 (12.1–19.5)	52.9 (50.2–55.7)	58.9 (53.4–64.4) *	54.6 (51.6–57.6)

Note: Data based on NHANES (National Health and Nutrition Examination Survey) 1999–2006; glomerular filtration rate as defined by the MDRD Study equation was used for definition of CKD. Values shown are percentages of participants with self-reported disability, with 95% confidence intervals in parentheses. For each item in a domain, the first set of values are unadjusted; in subsequent rows, the plus

sign indicates adjustments as follows. Demographics: adjusted for age, gender, and race; SES/access: adjusted for demographics demographics plus education, income (<20K vs. ≥20K), and routine site for healthcare; Clinical conditions: adjusted for demographics and SES/access plus diabetes, hypertension, cardiovascular disease, obesity, arthritis and cancer.

SES, socioeconomic status; ADL, activities of daily living (getting in and out of bed, using fork/knife/cup [eating], dressing oneself); IADL, instrumental activities of daily living (managing money, house chores, preparing meals); LSA, leisure and social activities (going to the movies, attending social event, leisure activity at home); LEM, lower extremity mobility (walking ¼ mile, walking up to 10 steps, stooping/kneeling/crouching, walking between rooms on same floor, standing up from armless chair); GPA, general physical activity (lifting or carrying heavy objects, reaching up overhead, grasping/holding small objects, standing for long periods, sitting for long periods); MDRD, Modification of Diet in Renal Disease; CKD, chronic kidney disease.

* $P<0.05$ vs. no CKD, by multivariable logistic regression, or across categories for unadjusted analyses, by χ^2 .

** $P<0.001$ vs. no CKD, by multivariable logistic regression, or across categories for unadjusted analyses, by χ^2 .