Epidemiology of Chronic Kidney Disease Among Older Adults: A Focus on the Oldest Old

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The National Kidney Foundation (NKF), Kidney Disease Outcomes Quality Initiative (KDOQI) Clinical Practice Guidelines for Chronic Kidney Disease: Evaluation, Classification, and Stratification expanded the focus of chronic kidney disease (CKD) management from end-stage renal disease (ESRD) to the entire spectrum of kidney disease including early kidney damage through the stages of kidney disease to kidney failure. A consequence of these guidelines is that a large number of older adults are being identified as having CKD, many of whom will not progress to ESRD. Concerns have been raised that reduced estimated glomerular filtration rate (eGFR) among older adults may not represent “disease” and using age-specific cut-points for staging CKD has been proposed. This implies that among older adults, CKD, as currently defined, may be benign. Several recent studies have shown that among people greater than or equal to 80 years old, CKD is associated with an increased risk for concurrent complications of CKD (eg, anemia, acidosis) and adverse outcomes including mortality and cardiovascular disease (CVD). Further, among older adults, CKD is associated with problems not traditionally thought to be associated with kidney disease. These nondisease-specific outcomes include functional decline, cognitive impairment, and frailty. Future research studies are necessary to determine the impact of concurrent complications of CKD and nondisease-specific problems on mortality and functional decline, the longitudinal trajectories of CKD progression, and patient preferences among the oldest old with CKD.

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IN 2002, the National Kidney Foundation (NKF) published the Kidney Disease Outcomes Quality Initiative (KDOQI) Clinical Practice Guidelines for Chronic Kidney Disease: Evaluation, Classification, and Stratification. These clinical practice guidelines expanded the focus of chronic kidney disease (CKD) management from end-stage renal disease (ESRD) to the entire spectrum of kidney disease, from early kidney damage through kidney failure (1). Prior to this, guidelines primarily addressed the hundreds of thousands of U.S. patients with ESRD who were receiving dialysis. The goal of increasing the scope of CKD diagnosis and management was to improve outcomes by indentifying CKD earlier in the course of the disease when treatment could potentially prevent the loss of kidney function and slow the progression of the disease, and efforts could be made to treat CKD-related comorbid conditions (1–3).

The NKF/KDOQI guidelines provided standardized terminology for staging CKD and recommend identifying those with CKD based on routine laboratory measurements. The terminology is used throughout this article and, thus, authors provide a brief overview. CKD is defined as a glomerular filtration rate (GFR) below 60 ml/min/1.73 m2 or by the presence of kidney damage for 3 or more months (1). Because measuring GFR is not feasible in routine clinical practice, the guidelines recommended estimating GFR using prediction equations that take into account serum creatinine concentration and factors that affect creatinine production including age, race, and gender (4,5). Kidney damage is defined as pathologic abnormalities or markers of damage, most frequently indentified by the abnormal presence of protein (eg, albumin) in the urine. CKD stage is assigned based on the level of kidney function, regardless...
of the underlying diagnosis. The stages range from 1 to 5, with higher stages indicating more severe CKD. Stages 1 and 2 include those with kidney damage (eg, urine albumin-to-creatinine ratio [ACR] \( \geq 30 \text{ mg/g} \)) and normal \( (\geq 90 \text{ ml/min/1.73 m}^2) \) and mild reduction \( (60–89\text{ ml/min/1.73 m}^2) \) in GFR, respectively. Stages 3 and 4 include those with moderate \( (30–59\text{ ml/min/1.73 m}^2) \) and severe \( (15–29\text{ ml/min/1.73 m}^2) \) reductions in GFR, respectively. Stage 5 CKD is defined as a GFR less than 15 ml/min/1.73 m^2 or receipt of renal replacement therapy. Many studies have focused on moderate-to-severe CKD, defined as an estimated glomerular filtration rate (eGFR) less than 60 ml/min/1.73 m^2. In early stages, the CKD action plan for patients with CKD focuses on diagnosis, treatment of comorbid conditions, and efforts to slow progression. At later stages, guidelines recommend for the preparation and initiation of kidney replacement therapy.

These guidelines have had a substantial affect on clinical practice and as a result CKD is now identified much earlier in the disease process (6). Additionally, as the publication of these guidelines, several epidemiological studies have determined the associations of CKD with adverse health outcomes in the general population, further highlighting the public health importance of CKD (7,8). However, as authors describe later, an unintended consequence of these efforts is that a very high percentage of older adults are being identified as having CKD. The care for older adults with CKD, or geriatric nephrology, has gained recent attention and has become a focus of epidemiological research studies, special interest groups at national meetings, and clinical education during nephrology fellowship training (9,10). However, prior studies of CKD in older populations often define older age as greater than or equal to 65 years. In fact, the greatest clinical challenge may be caring for the very old who have a higher burden of frailty, functional impairment, and multiple complex health care problems. Later, authors review data on the burden of CKD among older adults, the risk of ESRD among older adults, and the controversy and implications of applying the 2002 NKF/KDOQI guideline definitions of CKD to older adults. Next, authors discuss recent studies of CKD among older populations, describing the associations of CKD with concurrent complications, mortality, cardiovascular disease (CVD), and outcomes that are common among older adults, including functional decline, cognitive impairment, and frailty. Finally, authors outline future research directions.

### Applying CKD Definitions to Older Adults

#### Burden of CKD Among Older Adults

The prevalence of CKD increases markedly with age. In the National Health and Nutrition Examination Survey (NHANES) 1999–2004, the overall prevalence of CKD, defined as an eGFR less than 60 ml/min/1.73 m^2 or albuminuria greater than or equal to 30 mg/g based on a spot urine sample, was 13.1% (11). However, a graded increase in the prevalence of CKD was shown at older age groups. For example, in a related analysis using data from 30,528 participants from the NHANES 1988–1994 and 1999–2006 pooled cohort, the age-specific prevalence of reduced eGFR were calculated (12). To determine the prevalence among the oldest participants, age was stratified into four groups (<60, 60–69, 70–79, and 80+ years). The highest prevalence was found among those greater than or equal to 80 years of age (Figure 1).

In this study, high albuminuria was defined as an ACR of 30–300 mg/g on a spot random urine sample and very high albuminuria was defined as greater than 300 mg/g. Among participants greater than or equal to 80 years of age, 32.7% had an ACR greater than or equal to 30 mg/g (Figure 2).

The incidence of CKD has also been shown to increase with age. The association between age and incident CKD defined as a reduced eGFR (modified from the 2002 KDOQI guidelines to <59.25 ml/min/1.73 m^2 for women and <64.25 ml/min/1.73 m^2 for men) was evaluated for

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![Figure 1](https://example.com/figure1.png)

**Figure 1.** Prevalence of estimated glomerular filtration rate (eGFR) category by age group in the National Health and Nutrition Examination Survey (NHANES) 1988–1994 and 1999–2006 pooled cohort.

![Figure 2](https://example.com/figure2.png)

**Figure 2.** Prevalence of urinary albumin-to-creatinine ratio (ACR) category by age group in the National Health and Nutrition Examination Survey (NHANES) 1988–1994 and 1999–2006 pooled cohort.
among community-dwelling participants who were part of the Framingham Offspring Study (mean age at baseline: 43 years; [13]). For every 10 year increase in age, the odds ratio (OR; 95% confidence interval [CI]) for developing incident CKD was 2.56 (2.18–2.99). However, few studies have evaluated the association of age with incident CKD among those greater than or equal to 65 years old.

Risk for ESRD
CKD has been traditionally described as a disease associated with a progressive loss of kidney function with the expectation that a substantial proportion of these patients will develop ESRD and require renal replacement therapy. However, more than 90% of older adults with CKD die without progressing to ESRD (14,15). Although this might be due to the fact that older adults with CKD have a slower trajectory of decline, this is complicated by age-related differences in treatment decisions as some older adults decline dialysis treatment opting for conservative management (15).

In a pivotal study, O’Hare et al. (15) evaluated the association of reduced eGFR with both mortality and ESRD among 209,622 U.S. veterans with CKD. Analyses were stratified by age group (18–44, 45–54, 55–64, 65–74, 75–84, and 85–100 years). Among those 18–44 years old, the risk of ESRD exceeded the risk of death at an eGFR level less than 45 ml/min/1.73 m². In contrast, among those 65–84 years old, only those persons with an eGFR less than 15 ml/min/1.73 m² had a risk for ESRD that exceeded the risk for death. Among those 85–100 years old, the risk of death was higher than the risk of ESRD at any level of baseline eGFR. The risk of death was substantially higher than the risk of ESRD, especially among those with only moderate reductions in eGFR. For example, among participants aged 85–100 years with a moderate reduction in eGFR (45–59 ml/min/1.73 m²), the incidence of treated ESRD (95% CI) was 0.09 (0.03–0.15) per 100 person-years, compared with the incidence of death of 13.43 (12.38–14.49) per 100 person-years.

Controversy
As the data reviewed earlier demonstrate, applying the NKF/KDOQI staging criteria to the U.S. population identifies many older adults as having CKD, most of whom will not receive renal replacement therapy. Prior studies have shown an age-related decline in kidney function even among those without kidney disease risk factors (ie, hypertension, lower urinary tract disease [16]). Although glomerulosclerosis has been thought to explain this decline in GFR with age, a poor correlation between estimated GFR and pathologic findings on kidney biopsy has been shown (17). As well, there are concerns about the validity of GFR estimating equations in older populations (18). Taken together, these findings have led some to question the importance of reduced eGFR among older adults. Because of concerns that reduced eGFR among older adults may not represent “disease,” age-specific cut-points for staging NKF/KDOQI guidelines have been proposed. However, this implies that among older adults, CKD, as currently defined, may be benign. Until recently, there were few data on whether CKD among older adults was associated with metabolic complications and other adverse health outcomes.

CKD and Disease-specific Complications and Outcomes

Concurrent CKD Complications Among Older Adults
The rationale for using 60 ml/min/1.73 m² as a cut-point for the definition of moderate-to-severe CKD is based, in part, on the finding that GFR less than 60 ml/min/1.73 m² is associated with a higher prevalence of concurrent CKD complications (1). Several studies have documented the association between eGFR and metabolic complications commonly associated with CKD including anemia, hyperkalemia, acidosis, hyperphosphatemia, hypoalbuminemia, and hyperparathyroidism in the general population (19,20). If reductions in eGFR do not reflect kidney disease, but rather a normal aging process, then reduced eGFR would not be associated with these complications. Two recent studies addressed this by evaluating the associations of reduced eGFR with concurrent CKD complications stratifying by age (12,21).

In the first study, Bowling et al. (12) examined the age-specific (<60, 60–69, 70–79, and ≥80 years) associations between eGFR and six concurrent CKD complications among 30,528 participants from the NHANES 1988–1994 and 1999–2006 (n = 8,242 from NHANES 2003–2006 for hyperparathyroidism). Complications included anemia (hemoglobin, <12 g/dL in women and <13.5 g/dL in men), acidosis (bicarbonate, <22 mEq/L), hyperphosphatemia (phosphorus, ≥4.5 mg/dL), hypoalbuminemia (albumin <3.5 mg/dL), hyperparathyroidism (iPTH, ≥70 pg/mL), and hypertension (systolic/diastolic blood pressure, ≥140/90 mmHg or antihypertensive medication use). Within each age group, associations were present between lower eGFR and higher prevalence ratios for concurrent complications. Among participants greater than or equal to 80 years and compared with people with an eGFR greater than or equal to 60 ml/min/1.73 m², the multivariable adjusted prevalence ratios (95% CI) for people with eGFR levels of 45–59 and less than 45 ml/min/1.73 m² were 1.39 (1.11–1.73) and 2.06 (1.59–2.67) for anemia, 1.33 (0.89–1.98) and 2.47 (1.52–4.00) for acidosis, 1.11 (0.70–1.76) and 2.16 (1.36–3.42) for hyperphosphatemia, 2.04 (1.39–3.00) and 2.83 (1.76–4.53) for hyperparathyroidism, and 1.09 (1.03–1.14) and 1.12 (1.05–1.19) for hypertension, respectively.

In a similar study, Drawz et al. determined the age-specific prevalence of metabolic complications including anemia, hyperkalemia, acidosis, and hyperphosphatemia, stratified by level of eGFR using retrospective VA administrative data
This analysis included 13,874 patients in the Veterans Affairs (VA) Integrated Service Network 10. CKD was defined as an eGFR less than 60 ml/min/1.73 m², without a history of dialysis or kidney transplant, on two measurements between 90 and 365 days apart. The associations between reduced eGFR and anemia (hemoglobin level, <10 g/dL), hyperkalemia (potassium, >5.5 mEq/L), acidosis (serum bicarbonate, <21 mEq/L), and hyperphosphatemia (serum phosphorus, >4.6 mg/dL) were calculated. Participants were stratified by age (65–69, 70–74, 75–79, 80–84, and ≥85 years). Similar to the NHANES analyses, a higher prevalence of the metabolic complications was found at lower eGFR levels for all age groups. These studies suggest that reduced eGFR in older patients is not benign and puts people at increased risk for the metabolic complications typically associated with CKD. The authors of these studies suggest that physicians should consider monitoring elderly CKD patients for concurrent complications. However, both studies were limited by a cross-sectional design and temporal associations could not be assessed.

**Reduced eGFR and Mortality Among Older Adults**

Several studies have shown that CKD, defined as a reduced eGFR, is associated with an increased mortality risk in the general population (22). Age-specific associations of eGFR with mortality have been recently examined. A large study using VA administrative data from more than 2.5 million U.S. veterans showed that moderate reductions were not associated with increased mortality among older adults. Among younger veterans, there was a significant association between mild reduction in eGFR (50–59 ml/min/1.73 m²) and mortality, however, this association was attenuated at older ages. Specifically, among those greater than or equal to 65 years of age, the annual mortality rate was only about 10% higher among those with eGFR of 50–59 versus greater than or equal to 60 ml/min/1.73 m² (23). Although there was a significant association between eGFR level and mortality at eGFR levels 40–49 ml/min/1.73 m² and below among adults greater than or equal to 65 years of age, this association was weaker than for younger adults. All patients in this analysis were seeking care within the VA, and most of these patients were white men. In contrast, in a meta-analysis of general population cohorts conducted by the Chronic Kidney Disease Prognosis Consortium (CKD-PC), investigators evaluated the association between eGFR less than 60 ml/min/1.73 m² and increased risk for all-cause and cardiovascular mortality among adults less than 65 years of age and their counterparts greater than or equal to 65 years of age (24). Reduced eGFR was associated with an increased hazard ratio (HR) for all-cause mortality among individuals less than 65 years of age and greater than or equal to 65 years of age. The HR comparing eGFR levels of 45–95 ml/min/1.73 m² was 2.14 (95% CI: 1.56–2.92) and 1.60 (95% CI: 1.46–1.75) for individuals less than 65 years and greater than or equal to 65 years, respectively. Similar patterns of the age-stratified associations between eGFR and mortality were found in a meta-analysis of high-risk cohorts defined by having a history of hypertension, diabetes, or CVD (25). These studies stratified at an age of 65 years and did not provide information in older age groups.

In an analysis of the population-based REasons for Geographic and Racial Differences in Stroke (REGARDS) study, age-specific associations between level of eGFR and mortality were calculated (Figure 3; 26). Age-stratified (45–59, 60–69, 70–79, and ≥80 years) Cox proportional hazards models were used to calculate the HRs for all-cause mortality associated with eGFR level (≥60, 45–59, and <45 ml/min/1.73 m²). After adjusting for traditional CVD risk factors (eg, hypertension, high cholesterol, diabetes), among participants aged 70–79 years (n = 5823), the adjusted HR for mortality associated with eGFR levels of 45–59 and less than 45 ml/min/1.73 m², versus greater than or equal to 60 ml/min/1.73 m², were 1.3 (95% CI: 1.0–1.6) and 3.1 (95% CI: 1.2–1.8), respectively. Among those greater than or equal to 80 years of age (n = 1,669), the analogous multivariable adjusted HR (95% CI) for mortality were 1.6 (1.3–2.1) and 2.2 (1.7–2.9), respectively.

In this analysis, the HRs associated with an eGFR of 45–59 ml/min/1.73 m² were closer to the null for the older compared with younger age groups. However, comparisons of the magnitude of HRs across subgroups of the population with different baseline risk for outcomes should be considered with caution. As described by Howard and Goff (27), there may be a natural tendency to infer that a smaller HR among older adults means that a risk factor has decreased importance in this subgroup. In fact, a smaller relative increase in a group with a higher base mortality rate may have a greater public health impact.
**Albinurinuria and Mortality Among Older Adults**

Higher levels of albuminuria have been reported to be associated with increased mortality in prior studies of older adults with diabetes mellitus and in the general population. O’Hare et al. reported ACR levels greater than or equal to 30 mg/g to be associated with increased mortality, regardless of age, among U.S. veterans with diabetes mellitus (28). Also, the HR (95% CI) for all-cause mortality associated with higher ACR levels (4.8 vs 0.6 mg/mmol) was similar for adults less than 65 years (1.49; 1.40–1.59) and for adults greater than or equal to 65 years (1.52; 1.45–1.61) in the CKD-PC (24).

In an analysis of the REGARDS study, the age-specific association between albuminuria and all-cause mortality was evaluated (Figure 4:26). A spot urine sample was used to calculate ACR. Among participants greater than or equal to 80 years of age, the HR (95% CI) for mortality associated with ACR levels of 10–29, 30–299, and greater than or equal to 300 mg/g, versus less than 10 mg/g, were 1.7 (1.3–2.1), 2.5 (1.9–3.3), and 5.1 (3.6–7.4), respectively. Similar associations were found in the younger age groups studied (each test for interaction >.1). Compared with the study of U.S. veterans, REGARDS enrolled participants with and without diabetes mellitus and higher ACR was associated with increased HRs for mortality in each of these subgroups.

**Reduced eGFR and CVD Among Older Adults**

The association between CKD and CVD in the general population has been well described (7,29). Some, but not all, studies among older adults have also shown a higher risk of incident CVD and cardiovascular mortality among those with CKD, however. For example, in a large observational cohort of participants from the Netherlands, the association between eGFR less than 60 ml/min/1.73 m² and incident CVD events (fatal and nonfatal myocardial infarction, ischemic heart disease, stroke, or need for percutaneous or surgical cardiac interventions) was significant among those less than 60 years of age, but not among those greater than or equal to 60 years of age (30). In contrast, in an analysis of the associations of eGFR and ACR and CVD mortality, eGFR and ACR where shown to be strong risk factors for those greater than 70 years of age in a population-based, Norwegian general health survey (31).

The association between kidney function and CVD was studied among nearly 5,000 community-dwelling older adults who were part of the Cardiovascular Health Study. In this analysis, the association between level of eGFR and incident and recurrent CVD events was assessed (32). After adjusting for CVD risk factors, the HR (95% CI) for CVD associated with each 10 ml/min/1.73 m² lower eGFR level was 1.05 (1.02–1.09) and 1.04 (0.99–1.09) for incident and recurrent events, respectively.

**Albinurinuria and CVD Among Older Adults**

Albuminuria has been shown to be associated with CVD in the general population (29), however, albuminuria has been less well studied in older populations. In an analysis of Cardiovascular Health Study, the association of ACR with cardiovascular mortality, incident myocardial infarction, and incident heart failure (HF) was evaluated. ACR was divided into sex-specific quintiles. A graded increase in the association for cardiovascular mortality, myocardial infarction, and heart failure was found at higher ACR quintiles (33). This analysis included older adults greater than or equal to 65 years of age, but further age stratification to determine this association among the oldest-old was not performed.

**CKD and Nondisease-specific Outcomes**

Although ESRD, mortality, and CVD are important health outcomes for older adults with CKD, there is growing evidence that patients, especially those with chronic conditions, may identify more with problems or outcomes that are not disease-specific (34,35). Recent studies have evaluated the association between CKD and outcomes not traditionally considered a consequence of kidney disease. These nondisease-specific outcomes include functional decline, cognitive impairment, and frailty.

**Functional Decline**

Evaluation of functional status among older adults includes questions about ability to complete tasks such as instrumental activities of daily living (IADLs) and basic activities of daily living (BADLs) or questions of mobility. Completing IADL tasks requires intact physical and cognitive function and is important for maintaining independent community living. In cross-sectional studies, higher serum creatinine has been shown to be associated with lower self-reported physical performance and lower

Figure 4. All-cause mortality rates associated with level of albuminuria and age group in the Reasons for Geographic and Racial Differences in Stroke (REGARDS) study. PY = person years.

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eGFR is associated with being dependent in two or more BADLs (36,37). In an analysis of data from older adults who were part of the Health Aging and Body Composition Study, CKD, defined as an estimated eGFR less than 60 ml/min/1.73 m², was associated with the development of a persistent inability to walk one-quarter mile or climb 10 steps after multivariable adjustment that included measures of gait speed, strength, and inflammation (38). CKD has also been shown to predict incident limitations in mobility and worsening physical functional (39).

In an analysis of the University of Alabama at Birmingham Study of Aging, a prospective, observational study of a sample of community-dwelling Medicare beneficiaries greater than or equal to 69 years old, an association was assessed between CKD and the subsequent declines in both IADLs and BADLs over 2 years of follow-up (40). IADLs included using the telephone, light housework, heavy housework, preparing meals, shopping, and managing money, and BADLs included bathing, transferring out of a bed or chair, eating, toileting, and dressing. IADL declines occurred in 17%, 27%, and 55% of those with eGFR greater than or equal to 60, 45–59, and less than 45 ml/min/1.73 m², respectively. Compared with individuals with an eGFR greater than or equal to 60 ml/min/1.73 m², multivariable adjusted ORs (95% CI) for an IADL decline were 1.47 (0.80–3.17) and 3.12 (1.38–7.06) for participants with an eGFR of 45–59 and less than 45 ml/min/1.73 m², respectively. BADL decline occurred in 7%, 15%, and 33% of those with eGFR greater than or equal to 60, 45–59, and less than 45 ml/min/1.73 m², respectively, and the multivariable-adjusted OR (95% CI) were 1.96 (0.86–4.47) and 3.78 (1.46–9.77) for an eGFR of 45–59 and less than 45 ml/min/1.73 m², respectively, versus greater than or equal to 60 ml/min/1.73 m².

Cognitive Impairment

The prevalence of cognitive impairment and dementia has been shown to be substantially greater in the ESRD population (41). This has been thought to be, at least in part, a side effect of hemodialysis treatment. More recently, studies have evaluated the association between predialysis CKD and both prevalent and incident cognitive impairment. In a cross-sectional analysis or participants with an eGFR less than 60 ml/min/1.73 m² from the REGARDS study, the OR (95% CI) was 1.11 (1.04–1.19) for every 10 ml/min/1.73 m² lower GFR (42).

Prospective studies of the association between CKD and incident cognitive impairment have been conducted using data from the Heath ABC study, Cardiovascular Health Study, and REGARDS study (43,44). In an analysis of the Heath ABC study, the association between eGFR and cognitive decline defined as a modified Mini-Mental State Examination less than 80 or a decline by greater than 5 points at 2 and 4 years of follow-up (43). Compared with eGFR greater than or equal to 60 ml/min/1.73 m², participants with eGFR 45–59 and less than 45 ml/min/1.73 m² at baseline had a multivariable adjusted OR (95% CI) for cognitive decline of 1.31 (1.04–1.65) and 2.86 (1.73–4.75), respectively, during follow-up.

In analysis of the REGARDS study, the associations of reduced eGFR and elevated ACR with incident cognitive impairment were evaluated (44). Participants with cognitive impairment at baseline were excluded. Cognitive impairment was defined as a score of 4 or less on the Six-item Screener, which evaluates orientation and recall, during follow-up. Compared with those with ACR less than 10 mg/g, the multivariable adjusted OR (95% CI) for ACR 30–300 mg/g and greater than or equal to 300 mg/g were 1.31 (1.12–1.55) and 1.57 (1.15–2.14), respectively. Compared with an eGFR greater than or equal to 60, eGFR less than 60 ml/min/1.73 m² was not independently associated with incident cognitive impairment. However, after stratifying by ACR (<10, 10–29, 30–299, and ≥300 mg/g), among those with ACR less than 10, the OR (95% CI) for incident cognitive impairment comparing participants with an eGFR less than 60 versus greater than or equal to 60 ml/min/1.73 m² was 1.30 (1.02–1.66). This association was attenuated at higher ACR levels. The authors concluded that elevated ACR and reduced eGFR provide complementary but not additive information on the risk for cognitive impairment.

Frailty

Frailty is defined as increased vulnerability to stressors and decreased physiologic reserve across multiple organ systems and has been shown to be associated with mortality, falls, institutionalization and hospitalization (45). The association between CKD and frailty was evaluated using data from more than 10,000 participants who were part of NHANES III (46). The definition of frailty was modified based on the available data to include three or more of low body weight, slow walking, self-reported weakness, exhaustion, and low physical activity. Compared with people without CKD, the multivariable adjusted OR (95% CI) for frailty for CKD stages 1 or 2 (eGFR ≥60 with ACR ≥3.5 mmol/mg in women and ≥2.5 mmol/mg in men), stage 3a (eGFR 45–59 ml/min/1.73 m²), and CKD stage 3b–5 (eGFR < 45 ml/min/1.73 m²) were 2.21 (1.49–3.28), 2.48 (1.57–3.93), and 5.88 (3.40–10.16), respectively. This study was cross-sectional and the association between CKD and incident frailty has not been well studied.

Future Research Directions

Identifying reasons for the excess mortality and functional decline unique to older adults with CKD has the potential to provide avenues for intervention to reduce risk for these adverse outcomes. As described earlier, nondisease-specific problems (eg, cognitive impairment, frailty, and falls) are more common in patients with CKD versus patients without CKD. Also, these problems have been shown to be associated with mortality and functional decline in the
general geriatric population and may explain part of the excess mortality and functional decline among older adults with CKD (47–50). However, there are few data on the contribution of these factors on the excess mortality and higher rate of functional decline in this population. Further research is needed to determine whether innovative health care models that include interdisciplinary teams and care coordination may be superior to the current system in their capacity to address patients with the co-occurrence of CKD and non-disease-specific problems (51,52).

Because the competing risk for death at older ages is high, the majority of older adults with CKD will not develop ESRD. Although most observational research studies are limited by the measurement of eGFR at a single time point, in real-world clinical practice physicians often have access to patients’ measures of kidney function for months or years. Evaluating longitudinal eGFR trajectory is a novel approach to predicting decline in kidney function (53,54). Although CKD trajectory has recently been shown to be associated with increased risk for mortality among both younger and older adults (55–57), there are fewer data on whether prior trajectory of kidney function or other patient characteristics can be used to predict future eGFR declines and incident kidney failure among older adults.

Finally, as previously described, older adults may be more likely to prioritize global health and function over disease-specific outcomes (35). For example, among patients with diabetes, providers may prioritize glucose control and medication adherence. In contrast, older patients with diabetes prioritize functional outcomes such as independence in activities of daily living. Progression to ESRD is the traditional outcome of interest associated with CKD and the general approach to CKD management prioritizes preventing ESRD (51). However, as reported earlier, CKD is associated with multiple outcomes including both disease-specific and non-disease-specific. There are limited data on how older adults with CKD report and prioritize outcomes and health goals related to CKD. Further studies may require innovative methods such as qualitative approaches to elicit patient preferences and health goals. Identifying the health goals that are highest priority to older adults with CKD will facilitate the development of interventions that will support patient-centered care.

Conclusions

The prevalence of CKD has been shown to increase with age. Although most research on CKD in older adults has focused on individuals greater than or equal to 65 years, the more relevant clinical challenge may be caring for the very old, those greater than or equal to 80 years of age. Recent studies have shown that among those greater than or equal to 80 years old, CKD is associated with an increased risk for concurrent complications of CKD (e.g., anemia, acidosis), mortality, and CVD. Further, among older adults CKD is associated with function decline, cognitive impairment, and frailty. Future research studies are needed to determine the impact of non-disease-specific problems on mortality and functional decline, to evaluate longitudinal trajectories of kidney dysfunction among the oldest old, and to evaluate patient preferences among the oldest old with CKD.

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