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Socioeconomic Disparities in Chronic Kidney Disease

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Abstract

Chronic kidney disease (CKD) is a national public health problem that afflicts persons of all segments of society. While racial/ethnic disparities in advanced CKD including dialysis dependent populations have been well established, the finding of differences in CKD incidence, prevalence and progression across different socioeconomic groups and racial and ethnic strata has only recently started to receive significant attention. Socioeconomics may exert both interdependent and independent effects on CKD and its complications, and may confound racial and ethnic disparities. Socioeconomic constellations influence not only access to quality care for CKD risk factors and CKD treatment, but may mediate many of the cultural and environmental determinants of health that are becoming more widely recognized as impacting complex medical disorders. In this manuscript we have reviewed the available literature pertaining to the role of socioeconomic status and economic factors in both non-dialysis dependent CKD and end-stage-renal disease. Advancing our understanding of the role of socioeconomic factors in patients with or at risk for CKD can lead to improved strategies for disease prevention and management.

Keywords

poverty; chronic kidney disease; disparities; socio-economics; end-stage renal disease

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INTRODUCTION

Chronic kidney disease (CKD) is a growing public health problem that has become recognized globally as an important cause of premature morbidity and mortality [1–3]. Disparities in CKD may be related to many factors such as socioeconomic status (SES), gender, and race/ethnicity [4–6]. Rostand and colleagues brought national attention to this issue for the first time in the early 1980's when they reported a 4-fold higher race-specific risk for developing end stage renal disease (ESRD) among blacks in Jefferson County, Alabama, in comparison to their white counterparts [7]. A consistently higher rate of ESRD has subsequently been noted among other racial/ethnic groups over the last 30 years [8,9]. It should be noted that these high rates of ESRD occur despite similar or even lower prevalence rates of early stage CKD, reinforcing the need to better understand the multiple factors that conspire to influence progression to ESRD [9,10]. The excess rate of ESRD among minorities not only levies a personal toll on affected families and communities, but the excess prevalence of ESRD accounts for nearly a third of the $45 billion (Medicare and non Medicare) a year in U.S. ESRD costs alone [9].

Whereas disparities in CKD prevalence and progression have generally been thought to be a function of racial/ethnic, gender or genetic differences influencing the prevalence and/or control of CKD risk factors such as diabetes and hypertension, the role of the social environment and economic conditions has recently gained greater attention as an important element in the pathway from CKD risk to the development and complications of CKD and ESRD [11]. Indeed, the social environment has been cited as a key determinant in the persistence of health inequities in the U.S. Despite our recognized standing as a world leader in health technology and medical care, the U.S. ranks near last in preventable deaths among developed nations [12]. Dr. Steven Schroeder, former president of the Robert Wood Johnson Foundation, argued that "since the less fortunate are disproportionately affected by actionable social determinants of health, we must focus on this population to improve the health of the American and concentrate our strategies on health behaviors, social factors, health care, and the environment" [13]. This serves as a clear directive to establish greater social equity as part of a broad strategy to improve health outcomes among many vulnerable populations.

Theoretic Framework for Adverse Socioeconomic Status and Kidney Disease

Socioeconomically disadvantaged populations across the globe exhibit a disproportionate burden of CKD often complicated by the inability to receive evidence based care leading to suboptimum clinical outcomes [2,14]. A basic understanding of the vulnerabilities of the disadvantaged populations will facilitate the adaptation and adoption of the necessary policies to support kidney disease treatment and prevention guidelines [2]. Moreover, the World Health Organization has identified three key tenets to improving health at a global level that each reinforce the impact of socioeconomic factors: 1) Improve the conditions of daily life, 2) Tackle the inequitable distribution of power, money, and resources – the structural drivers of those conditions of daily life – globally, nationally, and locally, and 3) Develop a workforce trained in the social determinants of health, and raise public awareness about the social determinants of health [15]. The increasing impact of social factors and health

behaviors has contributed to the growing CKD epidemic positioning the nephrology community to lead the charge and deal with the challenge of providing quality care in the setting of contrasting financial, and public health policies to control costs [16]. A conceptual framework emphasizing the importance of socioeconomics as a mediator of key CKD prevention and treatment pathways highlights its vast impact on the CKD epidemic (figure 1). The figure shows that many of the determinants of CKD such as obesity, diabetes, hypertension and endothelial dysfunction, as well as chronic inflammation, neurohormonal activation and oxidative stress, may have their foundation in socioeconomic deprivation and its outcroppings or extensions. These include, but are not limited to discrimination and segregation, substandard living conditions, limited quality health care to the uninsured or underinsured, limited health literacy, poor educational systems and chronic stress that result in measureable and quantifiable pathologic factors that contribute to and enhance the development of CKD and eventually to ESRD and premature mortality [4,9,17–20].

Socioeconomic Class and Key Determinants of Health Values

The World Health Organization Commission on Social Determinants of Health has found that poor health of low income persons is directly related to the social gradient in health within and across countries caused by the unequal distribution of power, income, goods, and services, globally and nationally [21]. Importantly they have noted that unequal and unfair social policies, poor economic arrangements, and bad politics conspire to cause much of the health inequity in the world. This has been seen dramatically for many years in infectious disease morbidity and mortality, and now more recently in chronic diseases such as cardiovascular disease, diabetes, CKD and others[22]. Table 1 highlights the influence of socioeconomic class including income on the context of patient specific needs, values, and preferences. An individual's SES may actually considerably impact one's perception of seemingly mundane matters such as food, education, language and time. Indeed, while these concepts may be apparent and easily recognizable in other social disciplines, their presence and implications may be lost or concealed to many in the medical arena. Therefore, an understanding of how SES may influence world-views is critical for health professionals to truly understand the diverse patients they care for and how to better connect with them to optimize the effectiveness of traditional health strategies and recommendations.

Socioeconomic Status and Non-Dialysis-Dependent Chronic Kidney Disease

Several studies have highlighted a strong association between SES and the incidence, prevalence and complications of CKD [23–33]. In an analysis of over 14,000 adults in the third National Health and Nutrition Examination Survey (NHANES III) we found the presence of poverty, defined as less than 200% federal poverty level (FPL), was associated with a 35% greater odds of prevalent microalbuminuria and a 78% greater odds of prevalent macroalbuminuria[23]. However, after adjusting for age, sex, race, education, obesity, hypertension, diabetes, reduced estimated glomerular filtration rate (eGFR), and medication use, the odds of prevalent microalbuminuria was less robust but still significant (18%; $p<0.05$), but the association with macroalbuminuria was no longer significant. Importantly, even after multiple statistical adjustments racial/ethnic differences in macroalbuminuria were more apparent among the subset of less affluent study participants than in those >200% FPL [23]. Similarly, albuminuria was found to be associated with lower self-reported annual

household income in over 22,500 adult participants 45 years and older in the REasons for Geographic And Racial Differences in Stroke (REGARDS) Study, where Crews et al. also found that after multiple adjustments the self-reported annual household income <$20,000/year vs. >$75,000/year had a 1.34 greater odds of albumin to creatinine ratio (ACR) of 30–300mg/g and 2.36 odds of ACR >300mg/g for all participants and the relationship was more robust for blacks than whites, suggesting the effect of SES may be a determinant of racial disparities in albuminuria [24].

An analysis from the baseline examination data of the Jackson Heart Study assessed CKD status (albuminuria or eGFR <60 mL/min/1.73 m^2) in over 3,400 African American adults living in the tricounty region of the Jackson, Mississippi, metropolitan area and found high SES participants (family income at least 3.5 times the FPL or having at least 1 undergraduate degree) was associated with a 41% lower odds of prevalent CKD than their less affluent counterparts [26]. In a cohort of nearly 2,500 community-dwelling black and white adults age 30–64 years residing in Baltimore City, Maryland, stratified by SES (household income <125% FPL or higher) Crews and colleagues found low SES was independently associated with a 59% greater odds of CKD prevalence after adjusting for demographics, insurance status and comorbid disease, but there was no difference by race. However, when stratified by race, low SES was associated with CKD in African Americans, but not in whites, suggesting the role of SES to CKD may differ across racial/ethnic groups [27].

Similar to CKD prevalence, an increase in CKD incidence has also been associated with adverse SES. An assessment of CKD incidence among 5490 white and black residents with hypertension or diabetes enrolled in the Atherosclerosis Risk in Communities Study found that blacks had an increased risk for CKD compared to whites, of which 10% was explained by poorer access to health care and over 60% by demographic, socioeconomic, lifestyle and clinical factors [25].

An evaluation of a cross-sectional sample of U.S. adults that included over 16,000 adults who participated in the NHANES 1999–2006 found in adjusted analyses uninsured adults with non-dialysis dependent CKD were 40% less likely to be treated for their hypertension and 55% less likely to be receiving recommended therapy with angiotensin inhibitors compared to those with insurance coverage [28]. The uninsured cohort was also more likely to be under the age of 50 years (62.8% vs. 23.0%, $p < 0.001$) and nonwhite (58.7%, vs. 21.8%, $p < 0.001$) compared with their insured counterparts [28]. These findings reinforce some of the key pathways through which SES may mediate CKD progression and the public burden of ESRD. In addition, based on a Beck Depression score low SES as determined by unemployment and low income, as well as lower quality and satisfaction with life scale scores among 628 African Americans with hypertension and CKD was independently and significantly associated with a greater degree of depression, an important co-existing condition in persons with CKD [29].

The impact of individual or household income versus community poverty level on CKD outcomes is not clear. To investigate this issue McClellan et al. reported data from over 22,000 participants in the REGARDS cohort study in the Southeast U.S., finding household

income (<$15,000) versus community poverty (≥25% of the community households were below the FPL) and found household income, but not community poverty, was independently associated with CKD (eGFR 10–59 ml/min/1.73 m^2) prevalence [33]. They also found that adjusting for household income attenuated, but did not fully account for the higher CKD prevalence in blacks compared with whites.

In summary, while low SES was strongly associated with albuminuria in unadjusted analyses, after adjusting for multiple factors such as demographic, clinical and laboratory variables, the association was much more modest. By contrast SES remained strongly associated with CKD as defined by reduced eGFR (<60 ml/min/m^2) even after adjusting for multiple factors (table 2).

Socioeconomic Status and End-Stage Renal Disease

Similar to non-dialysis-dependent CKD, several studies have highlighted a strong association between SES and the incidence, prevalence and complications of ESRD [34–38]. In an analysis of 79,943 black and white participants in the Southern Community Cohort Study, Lipworth et al. found low income (income below vs. above $15,000) was associated with a 50% increased risk of ESRD and that the 3.5 fold increase in black-white ESRD incidence was attenuated, but not eliminated, after controlling for known risk factors in a cohort closely matched by socioeconomics [34]. Like low income, homelessness might impact ESRD risk. Hall et al. also examined time to ESRD and death in over 15,000 urban and mostly poor adults (73% with annual income <$15,000) with CKD utilizing a public health safety-net system and found that racial/ethnic minorities had a 2.2–4.0 fold higher risk of progression to ESRD compared with white persons with CKD, which was not explained by lower relative mortality, which could increase their likelihood of progressing to ESRD [35]. In addition to many urban adults with low SES being more likely to be under- or un-insured, they also are at greater risk of homelessness. When Hall and co-workers re-examined this urban and mostly poor cohort they found that 858 adults were homeless. The homeless group was younger, disproportionately male, and uninsured, and not only did they suffer from far higher rates of depression and substance abuse compared to adults with stable housing ($P < 0.001$), but over a follow-up period of nearly 3 years had a 80% crude and 28% adjusted higher risk of ESRD or death suggesting homeless adults with CKD suffer from increased CKD morbidity and mortality [32].

Of 86,588 adults younger than 65 years in the National Kidney Foundation's Kidney Early Evaluation Program which screened persons at risk for CKD (history of diabetes or hypertension, or family history of CKD), Jurkovitz et al. found uninsured participants were 82% (adjusted) more likely than privately insured participants to die and 72% (adjusted) more likely to develop ESRD [39]. Thus, lack of insurance, which is more common among low SES persons, is an independent risk factor for early death and ESRD in this high risk population [39]. While health insurance was associated with improved survival in this cohort, having a primary care provider or nephrologist did not affect the risk of survival, suggesting the need to explore the connection between insurance, primary care access and outcomes in persons at high risk of or with CKD [31].

The impact of income on outcomes for patients with ESRD, who are largely relieved of structural and insurance barriers to care due to the Medicare ESRD program, is poorly understood. In a cohort of over 3,000 ESRD patients Garg et al. reported higher neighborhood income was associated with decreased mortality and an increased likelihood of placement on the renal transplant waiting list [36]. The presence of private insurance coverage in addition to Medicare improved rates of listing for transplantation in a graded manner, but had no effect on socioeconomic disparities in mortality, suggesting greater health benefits can attenuate financial barriers to transplantation in low-income patients [36]. The effects of low SES could also be mediated through structural barriers to care. While an assessment of distance from patient residence to transplant center did not predict placement on the transplant waitlist in over 35,000 subjects in ESRD Network 6 (Georgia, North Carolina, or South Carolina), increasing neighborhood poverty was associated in a gradated manner with greater likelihood of decreased placement on the transplant waitlist for all patients, but the effect was even greater in blacks than in whites [37]. When Volkova and co-workers explored the contribution of neighborhood poverty to racial disparity in ESRD incidence by examining census tract level neighborhood poverty in over 34,000 patients in ESRD Network 6 they found census tract was strongly associated with higher ESRD incidence for both blacks and whites [38]. Increasing levels of census tract poverty was associated with a greater disparity in ESRD rates between blacks and whites, while census tracts with lesser poverty had more similar ESRD rates by race suggesting an interaction between race and poverty [38].

In summary, low SES was strongly associated with risk for ESRD progression and or death even after adjusting for multiple factors such as demographic, clinical and laboratory variables suggesting a strong link between social and economic deprivation and progression to severe kidney disease and premature death (table 3).

Socioeconomic Status and Genetic Risk Factors

Among 736 African Americans participating in the Cardiovascular Health Study who were aged >65 years a low income (<$8000/year vs. >$35,000/year) was associated with a 3-fold greater odds of prevalent CKD assessed by cystatin C or serum creatinine based eGFR, while there was no association between genetic African ancestry and CKD, suggesting a strong influence of social and environmental factors [40]. While African ancestry alone has not been shown to increase the risk of CKD, recent studies have identified that persons with two allelic variants of the APOL1 gene which is particularly prevalent in African Americans is associated with increased risk of progression to ESRD in the presence of CKD such as hypertension, diabetes, and HIV related CKD as well as focal glomerulosclerosis [41–43]. These APOL1 gene variants are associated with protection of trypansomiasis and are most highly prevalent in western Africa where they are estimated to have developed 4,000 years ago, well prior to the original migration of humans from Africa to Europe, but well before the transatlantic slave trade leading to the high prevalence in African Americans [44]. Importantly socioeconomic stresses can lead to neurohormonal and/or epigenetic changes that could adversely impact CKD[45] as well as CKD risk factors such as blood pressure, metabolic pathways, oxidative stress, inflammatory mediators and/or other signaling factors [46–49]. Given the emerging evidence of epigenetic alterations contributing to CKD

and ESRD risk,[45,50] it is conceptually plausible that socioeconomic depravity can contribute to not only societal and health system level inequities in care leading to adverse outcomes (figure 1), but to epigenetic changes that can influence the expression of CKD and CKD risk factor genes and signaling factors (figure 2). The reversible nature of the epigenetic changes[51] gives a unique opportunity to halt or even reverse socioeconomic induced epigenetic disease processes through targeted social interventions or to create targeted interventions to attenuate the biologic alteration of low SES while social changes, which often take generations to occur, are being implemented.

CONCLUSION

The increasing rates of poverty and exposure to adverse social determinants of health, both in the U.S. and globally is reaching a level of crisis [13,52]. The nephrology community and related stakeholders should unite in a strategic effort to address the clinical, financial, and public policy issues that will enable the delivery of appropriate CKD care to low socioeconomic and other vulnerable patient populations [16]. The Affordable Care Act (ACA) has dramatically increased the number of low-income nonelderly adults eligible for insurance overage including Medicaid,[53] and may have favorable overarching consequences on mitigating prior disparities. A recent survey from Barcellos et al. found that lower income persons (100–250% FPL) in comparison to higher income persons (≥400% FPL) were 31% less likely to score above the median on ACA knowledge, and 54% less likely to score above the median on health insurance knowledge suggesting low SES can adversely impact understanding of the ACA and may limit its success [54]. In addition to extending health insurance coverage, the ACA of 2010 allowed introduction of bundled payments for a range of services, proposed the creation of accountable care organizations (ACOs), and established the Centers for Medicare and Medicaid Innovation to test new care delivery and payment models aimed to improve quality of care and contain costs with many of the demonstration programs being introduced in the nephrology community [55,56]. The implications of ACA for CKD are substantial given the tremendous role that the nephrology community has played in piloting key ACA demonstration programs [55,57,58]. To gain a sense of the potential impact of extending health insurance coverage, Kurella-Tamura et al. found that low-income nonelderly adults covered by states with Medicaid broader coverage (closer to the projected impact of ACA) had a significant decrease in ESRD incidence (1.8% for each additional 10% of the low-income nonelderly population covered by Medicaid) and a reduction in gaps to access to care between those with private insurance and those with Medicaid in access to peritoneal dialysis, kidney transplant waiting list, and kidney transplantation [59]. The ACA may set the stage for not only more available care but more structured medical care systems which can help improve renal outcomes [60]. However, education of the potential benefits of the ACA directed towards lower income persons will need to be enhanced [54].

An important challenge for the nephrology community as well as the broader medical community is to rethink how we might improve each element that impacts the health outcomes we are trying to achieve, and not just those limited to a procedure or prescription. Increased awareness of social and environmental factors that contribute to CKD disparities must be followed by cost effective policies to improve CKD/ESRD prevention and care,

especially in the setting of increasing diversity and increasing disparities in wealth and educational attainment [4,9,60–62]. As health care providers, we can directly address many of the factors crucial for closing the CKD/ESRD disparities gap, and while other factors may seem beyond our reach, we should not turn a blind eye to those elements of institutionalized racism entrenched within the fabric of our society, such as social injustice and human indifference [11,61]. Examples of evidence-based initiatives to mitigate untoward effects of socioeconomic deprivation include expanding awareness of CKD in vulnerable communities and high-risk individuals such as through the National Kidney Foundation Early Evaluation Program or mobile clinics[63–66] and implementing strategies to increase health literacy even among low-educational groups with or at risk for CKD with use of videos and/or novellas,[67,68] the use of social support such as social networks,[19] and primary intervention strategies including the use of lay health workers and patient navigators to address CKD and CKD risk factors ranging from diabetes to childhood chronic diseases[63,66,69,70]. Finally, we should not miss the opportunity to learn important lessons as we strive to advance the necessary policies to improve social welfare and health outcomes, as the existence of health inequities provides unique, unrecognized opportunities for understanding biologic, environmental, sociocultural, and health care system factors that can lead to improved clinical outcomes [4,5,9,60,61].

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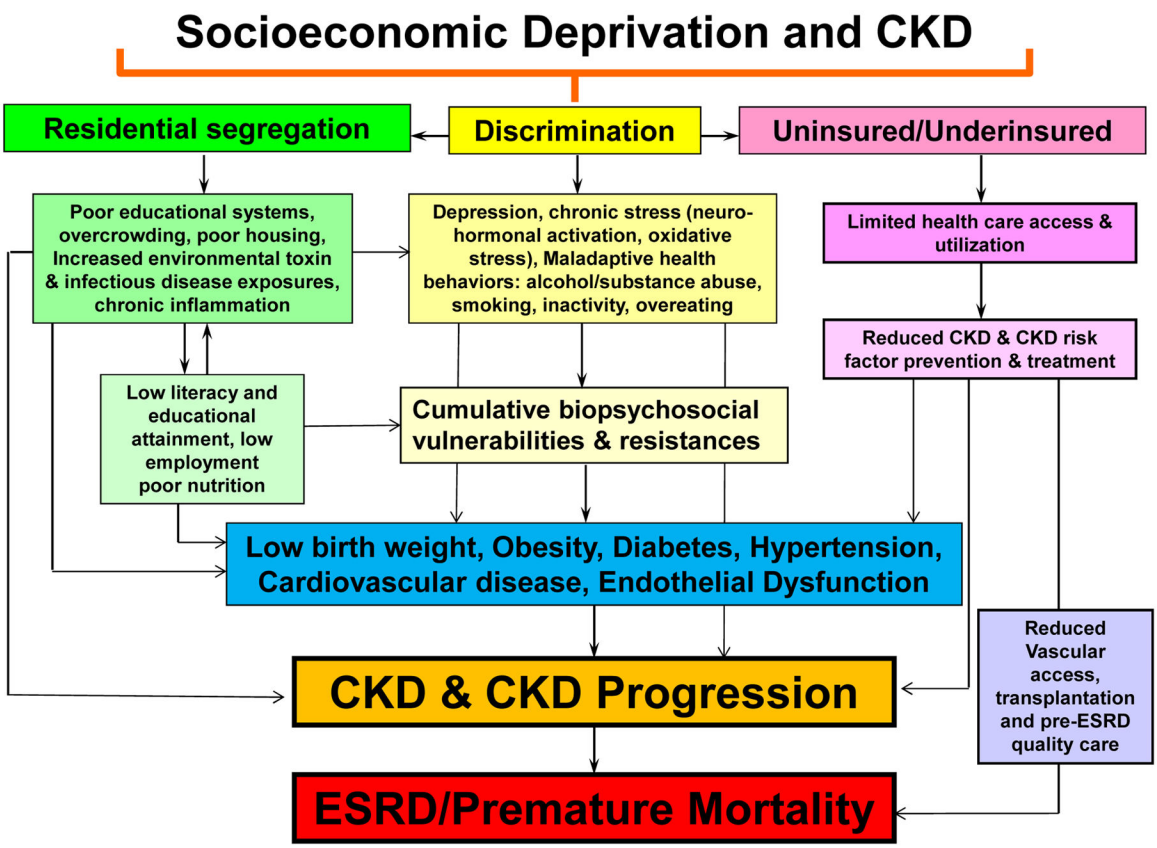

Figure 1.

Conceptual model of the inter-relationship between socioeconomic deprivation and chronic kidney disease

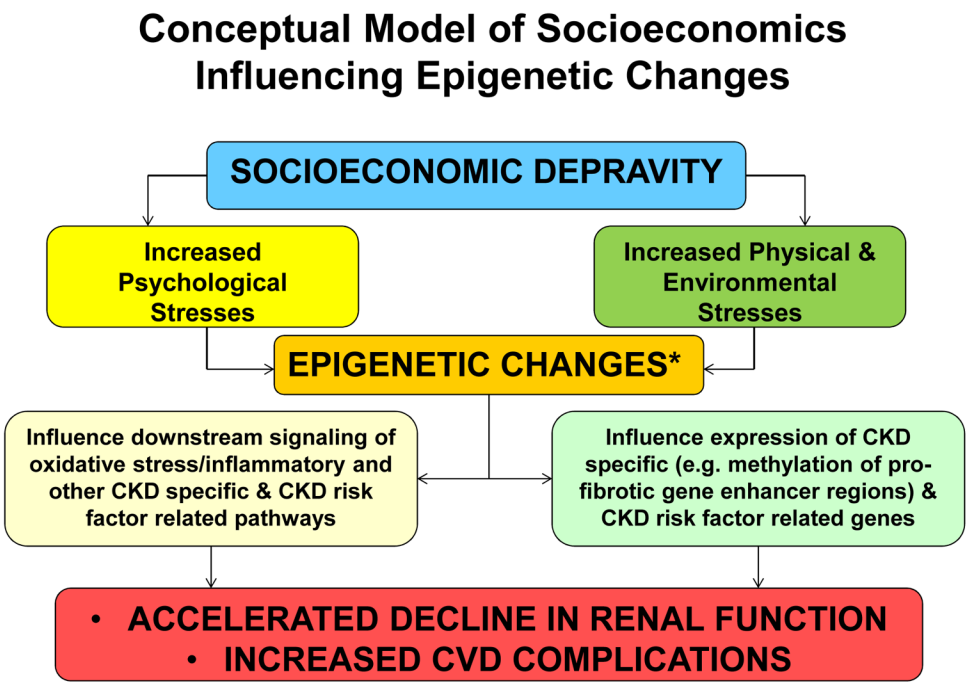

Figure 2.

Conceptual model of socioeconomics influencing epigenetic changes

* As well as neurohormonal changes

Table 1

Socioeconomic Class and Values of Key Determinants of Health adapted from Payne and Blair [71]

	POVERTY	MIDDLE CLASS	WEALTH
FOOD	Key question: Did you have enough? Quantity important.	Key question: Did you like it? Quality important.	Key question: Was it presented well? Presentation important.
EDUCATION	Valued and revered as abstract but not as reality.	Crucial for climbing the success ladder and making money.	Necessary tradition for making and maintaining connections.
DESTINY	Believes in fate. Cannot do much to mitigate chance.	Believes in choice. Can change future with good choices now.	Noblesse oblige.
LANGUAGE	Casual register. Language is about survival.	Formal register. Language is about negotiation.	Formal register. Language is about networking.
FAMILY STRUCTURE	Tend to be matriarchal.	Tends to be patriarchal.	Depends on who has money.
WORLD VIEW	Sees the world in terms of local settings.	Sees the world in terms of national settings.	Sees the world in terms of international view.
TIME	Present most important. Decisions made for the moment based on feelings or survival.	Future most important. Decisions made against future ramifications.	Traditions and history most important. Decisions made partially on the basis of tradition and decorum

Table 2

Selected studies of socioeconomics and chronic kidney disease

Condition	Participants	Key Findings	Ref
Albuminuria	~14,000 adults in national survey (NHANES)	<200% FPL was associated with a 35% greater odds of microalbuminuria (18% adjusted, p<0.05), and 78% greater odds of macroalbuminuria (NS after adjusted)	23
Albuminuria	22,500 white and black adults ≥45 years in the Southeast U.S. (REGARDS cohort study)	After multiple adjustments persons with self-reported annual household income <$20,000/year vs. >$75,000/year had a 1.34 greater odds of albumin to creatinine ratio (ACR) of 30–300mg/g and 2.36 odds of ACR >300mg/g.	24
CKD Prevalence (albuminuria or eGFR <60)	3,430 African American adults in Tri-county region of Jackson, MS	Family income ≥3.5 times FPL or at least 1 undergraduate degree was associated with a 41% lower odds of CKD vs. less affluent counterparts	26
CKD prevalence	2,500 community-dwelling black and white adults age 30–64 years residing in Baltimore City, MD	After adjusting for demographics, insurance status and comorbid disease household income <125% vs ≥125% of FPL was associated with 59% greater adjusted odds of CKD. In stratified analyses the association was noted in African Americans, but not in whites.	27
CKD Prevalence (eGFR <60)	736 African Americans > 65 years at multiple sites across the nation	Income <$8000/year vs. >$35,000/year was associated with a 3 times greater odds of CKD. There was no association between genetic African ancestry and kidney function	40
CKD incidence	5490 white and black residents with diabetes or hypertension at multiple sites across the nation	Blacks had increased risk for CKD compared to whites; 10% was explained by lesser access to health care and over 60% was explained by demographic, socioeconomic, lifestyle and clinical factors.	25
Blood pressure control in CKD	Over 16,000 adults in a national survey NHANES 1999–2006	Uninsured persons with non-dialysis dependent CKD were 40% less likely to be treated for their hypertension compared to insured persons.	28
CKD prevalence (eGFR 10–59)	628 African American adults at multiple sites across the nation	Low SES as determined by unemployment and low income associated with a greater degree of depression	29
CKD prevalence (eGFR 10–59)	~22,000 Black and White adults ≥45 years in the Southeast U.S. (REGARDS)	Household income (<$15,000) but not community poverty (≥ 25% of the community households below FPL) was independently associated with CKD	33

Chronic kidney disease – CKD; estimated glomerular filtration rate – eGFR in mL/min/1.73 m^2; federal poverty level – FPL; end stage renal disease – ESRD; socioeconomic status – SES; National Health and Nutrition Examination Survey – NHANES; REasons for Geographic And Racial Differences in Stroke Study – REGARDS; National Kidney Foundation Kidney Early Evaluation Program – KEEP

Table 3

Selected studies of socioeconomics and end stage renal disease

Condition	Participants	Key Findings	Ref
Risk of ESRD	79,943 black and white participants in the Southern Community Cohort Study	Income below vs. above $15,000 was associated with a 50% increased risk of ESRD. A 3.5 fold increase in black-white ESRD incidence was markedly attenuated, after controlling for known risk factors in a SES matched cohort	34
Risk of ESRD or death	15,000 urban, mostly poor adults with CKD in the San Francisco Community Health Network	In this low SES cohort (73% < $15,000/year) racial/ethnic minorities had a 2.2–4.0 fold higher risk of progression to ESRD compared with white persons with CKD	35
Risk of ESRD or death	15,000 urban, mostly poor adults with CKD in the San Francisco Community Health Network	In this low SES cohort (73% < $15,000/year), a subgroup of 858 homeless persons followed over ~3 years. had a 80% crude and 28% adjusted higher risk of ESRD or death vs. adults with stable housing. They also suffered from higher rates of depression and substance abuse ($P < 0.001$).	32
Risk of ESRD or death	86,588 adults <65 years in a national CKD screening program (KEEP)	Uninsured participants with or at risk for CKD were 82% (adjusted) more likely than privately insured participants to die and 72% (adjusted) more likely to develop ESRD.	39
Risk of death	138,331 adults <65 years in a national CKD screening program (KEEP)	The lack of having a primary care provider or nephrologist was not associated with increased risk for death in persons with or at risk for CKD (unlike being uninsured – ref [39])	31
Risk of death or placed on transplant list	3,000 ESRD patients	Higher neighborhood income was associated with decreased mortality and an increased likelihood of placement on the renal transplant waiting list.	36
Risk of placement on the transplant waitlist	35,000 ESRD patients in Network 6 (Georgia, North Carolina, or South Carolina)	Distance from patient residence to transplant center did not predict placement on the transplant waitlist. Increasing neighborhood poverty was associated with greater likelihood of decreased placement on the transplant waitlist and the effect was even greater in blacks than in whites	37
Risk of ESRD	34,000 patients in ESRD Network 6 (Georgia, North Carolina, or South Carolina)	Neighborhood poverty (census track level) was strongly associated with higher ESRD incidence for both blacks and whites. Increasing levels of census track poverty was associated with a greater disparity in ESRD rates between blacks and whites, suggesting an interaction between race and poverty	38
Risk of ESRD incidence, kidney transplant waiting list, and kidney transplantation	408,535 adults aged 20 to 64 from national administrative dataset (Medicaid)	Low-income nonelderly adults covered by states with Medicaid broader coverage (closer to the projected impact of ACA) had a 1.8% lower ESRD incidence for each additional 10% of the low-income nonelderly population covered by Medicaid. There was also a reduction in gaps to access to care between those with private insurance and those with expanded Medicaid in access to peritoneal dialysis, kidney transplant waiting list, and kidney transplantation.	59

Chronic kidney disease – CKD; end stage renal disease – ESRD; socioeconomic status – SES; federal poverty level – FPL; National Health and Nutrition Examination Survey – NHANES; REasons for Geographic And Racial Differences in Stroke Study – REGARDS; National Kidney Foundation Kidney Early Evaluation Program – KEEP