Clark-Cutaia MN, et al., J Nephrol Renal Ther 2021, 7: 061
DOI: 10.24966/NRT-7313/100061

HSOA Journal of
Nephrology & Renal Therapy

Research Article

Adult Health Behaviors Associated with Chronic Kidney Disease: 2003-2006 NHANES Data

Maya N Clark-Cutaia[1]*, Eleanor Rivera[2], Jule Ann Henstenberg[3], Laura Grunin[1] and Gary Yu[1]

[1]*New York Univeristy Rory Meyers College of Nursing, New York, USA*

[2]*University of Illinois at Chicago College of Nursing, Chicago, USA*

[3]*MANNA: Metropolitan Area Neighborhood Nutrition Alliance, Philadelphia, USA*

Abstract

The study objective was to explore the distribution of healthy behaviors across the Chronic Kidney Disease (CKD) spectrum using a national sample. A secondary data analysis of The National Health and Nutrition Examination Survey data from 2003-2006 was conducted. Participants ≥21 with chronic kidney disease were included in these analyses (N=8,489). We assessed sociodemographic characteristics, body mass index functional mobility, tobacco use, alcohol consumption, sleep, physical activity, and healthy eating. Bivariate analyses were conducted to assess associations between clinical characteristics or health behaviors and CKD stage. Older aged participants had advanced stages of CKD. Women had higher rates of stages 3-4. There was an over-representation of Black individuals with stage 5, and high school graduates in stages 4 and 5. Advanced stages were more likely to be diagnosed with comorbid conditions. Most patients were overweight or obese in stages 1-4, yet over 50% with stage 5 were at ideal weight. Participants with stages 3b-5 were more likely to have difficulty with functional mobility. Half of participants with stages 1-4 were non-smokers, but only 30% of stage 5. Rates of alcohol consumption decreased in advanced stage CKD. Most of the sample (~80%) got less than 7 hours of sleep per night regardless of CKD stage. Physical activity rates decreased with advanced stage. Most of the sample had low scores for healthy eating regardless of staging. Overall, BMI was high, while sleep, physical activity, and healthy eating behaviors were low. There are clinical opportunities to improve CKD progression and outcomes.

Keywords: Chronic kidney disease; Health behaviors; Risk factors; Self-management

***Corresponding author:** Maya N Clark-Cutaia, New York Univeristy Rory Meyers College of Nursing, New York, USA, Tel: +1 2129985280; E-mail: mc7009@nyu.edu

Citation: Clark-Cutaia MN, Rivera E, Henstenberg JA, Grunin L, Yu G (2021) Adult Health Behaviors Associated with Chronic Kidney Disease: 2003-2006 NHANES Data. J Nephrol Renal Ther 7: 061.

Received: October 22, 2021; **Accepted:** October 28, 2021; **Published:** November 06, 2021

Introduction

Maintenance of health behaviors is critical to slow the progression of Chronic Kidney Disease (CKD), prevent patients from reaching End Stage Renal Disease (ESRD), and improve morbidity and mortality [1-4]. This is challenging for the CKD population which has documented overall low levels of disease knowledge and treatment adherence [5]. Later stage CKD clinical management is increasingly dependent on lifestyle modification and self-management, which can include a number of possible health behaviors: increased physical activity, diet and weight loss, smoking cessation, reduced alcohol consumption, and sleep [6-9].

Individuals often struggle to integrate new health behaviors into their lives despite research-supported interventions that attempt to modify those behaviors [10,11]. For physical activity in particular, differences in factors such as work schedules or life commitments can manifest in different patterns of physical activity. In a previous study, we identified patterns of high and low levels of physical activity among healthy adults, which differed in their sociodemographic and clinical factors [12].

Maintaining dietary and fluid restrictions and healthy body weight have the potential to have a multitude of positive effects on the health of the patient living with CKD. In particular, dietary modifications can thwart the progression of comorbid conditions such as diabetes and hypertension. Obesity alone is an independent risk factor for CKD [13]. Weight loss has been shown to normalize Glomerular Filtration Rates (GFR) and reduce BP and microalbuminuria. For those in the advanced stages of CKD, dietary and fluid restrictions may reduce the need for ultrafiltration and the number of symptoms experienced during dialysis. Dietary sodium restriction, for example, has been shown to reduce mortality in hemodialysis patients [14].

Smoking cessation contributes to kidney health in a number of ways, with a large impact on blood pressure, a common extant kidney stressor. Smoking also has direct negative effects on both the kidneys and vascular system [15,16]. Similarly, alcohol consumption can affect the kidneys beyond the exacerbation of hypertension, diabetes, and liver disease [17-19]. Binge drinking episodes can lead to repeated acute kidney injuries, and regular alcohol consumption also leads to gradual kidney damage [20]. Studies also indicate that sleep disturbances, e.g. short duration and poor quality, are unrecognized risk factors for disease progression [21]. Additionally, patients with CKD have an increased prevalence of sleep apnea, which has been associated with an increased risk of cardiovascular events and mortality in CKD patients compared with the general population [22].

Lifestyle modifications are a mainstay of CKD treatment. Therefore, the goal of this study was to explore the distribution of healthy behaviors in patients across the CKD spectrum using a national sample of adults. These findings will advance our knowledge about how sociodemographic, health behavior, and clinical characteristics are associated with patients along the CKD continuum. Ultimately, this work can inform targeted interventions to improve adherence to prescribed health behaviors in patients with CKD.

Methods

Database

The National Health and Nutrition Examination Survey (NHANES) data consists of health, nutrition, and health behavior information collected annually from noninstitutionalized United States (U.S.) civilians by the Centers for Disease Control and Prevention (CDC). The National Center for Health Statistics (NCHS) Research Ethics Review Board approves all NHANES related protocols and procedures [23]. These protocols and procedures are previously described to include recruitment, enrollment, consenting and data collection [23].

Sample

A multistage probability sampling design was utilized in NHANES to approximate a representative sample of the U.S. population. Our analysis aimed to identify patterns of health behavior maintenance across CKD stages. Therefore, only data from NHANES cohorts which included those health behavior variables (2003-2004 and 2005-2006) were included in these analyses. All participants over the age of 21 with an estimated GFR (eGFR) consistent with CKD were included in these analyses (N=8,489).

Measurements

Sociodemographic characteristics (i.e., age, gender, race/ethnicity, and education) were self-reported. Chronic health conditions, defined as conditions diagnosed by a healthcare provider (i.e., diabetes, heart failure, coronary artery disease, cancer, and stroke), were also obtained via self-report. Responses were coded as "yes," "no," or "don't know."

The Kidney Disease: Improving Global Outcomes (KDIGO) guidelines define stages of kidney disease based on eGFR and proteinuria, to aid in early diagnosis and treatment of earlier stage chronic kidney disease. The eGFR was calculated using the Modification of Diet in Renal Disease study formula: eGFR=175 X [(calibrated serum creatinine in mg/dl)^(-1.154)] x [age^(-0.203)] x (0.742 if female) x (1.210 of African-American). Chronic Kidney Disease Stage 1 is normal or higher kidney function (eGFR>90). Stage 2 is mildly decreased kidney function or an eGFR of 89-60. Stage 3 has both an A and B with eGFR of 59-45 and 44-30 respectively. Severely decreased kidney function (Stage 4) correlates with an eGFR of 29-15 and Stage 5 or ESRD has an eGFR of <15 and may require renal replacement therapy.

Body Mass Index (BMI) was calculated using the formula weight (kilogram)/[height (meter)^2]. Heights and weights were measured as per the NHANES protocol by trained technicians. Obesity was defined as a BMI ≥30; overweight as a BMI≥25 and <30; and underweight by as a BMI<18.5 [24]. An ideal BMI was defined as ≥18.5 and <25.

Participants were dichotomized as "any difficulty" if they responded "yes" to queries about limitations in the work they can do due to a physical, mental, or emotional problem; needing special equipment to walk; limitations related to confusion; difficulty climbing 10 stairs or walking a quarter mile. Participants were dichotomized as "no difficulty" if they responded "no" to the same.

Survey items queried smoking history. Queries included "Have you smoked at least 100 cigarettes in your life?" and "Do you smoke cigarettes now?" Current smokers reported smoking "every day" or "some days." Former smokers responded "yes" to smoking at least 100 cigarettes in their life, and "not at all" to smoking cigarettes now. Non-smokers responded "no" to smoking at least 100 cigarettes in their life and "not at all" in regard to actively smoking.

For alcohol use, participants were categorized as none, moderate, or heavy based on a series of queries. Non-drinkers responded "no" to consuming at least 12 alcoholic beverages during any 1 year or over their lifetime or reported "0 drinks" over the past 12 months. Heavy and moderate drinkers were identified by calculating the number of drinks per week from participant responses to the number of days participants reported drinking per week, per month, or per year and the number of drinks participants reported drinking on those days. Gender-specific thresholds were used to identify moderate (≤7 drinks per week for women, ≤14 drinks per week for men) and heavy drinkers (>7 drinks per week for women, >14 drinks per week for men) [25].

The sleep variable was assessed objectively during bedtime and calculated via accelerometery duration of time spent in bed. Participants were donned a uni-axial accelerometer for seven consecutive days, removed only while in water (Actigraph 7164 Pensacola, FL). Periods of accelerometer removal were defined as intervals of 60 minutes without measured activity; 1-minute of counts between 0 and 100 were also excluded [26-27]. Time-in-bed was defined as the duration between initiation and conclusion in-bed intervals expressed in minutes. Time-in-bed was calculated daily [28,29]. Time-in-bed duration is similar to sleep duration derived from self-report [30]. Average time-in-bed durations were dichotomized using a cut-off of 7 hours of sleep per day [31].

Physical activity was obtained via patient self-report during a household interview. Participants responded to the number of times they engaged in approximately 60 individual leisure activities per day, per week, or per month. Responses were transformed to characterize the number of times participants were active over the past 30 days. Participants reported level of exertion when active (moderate or vigorous) and the average number of active minutes. Activity was excluded if reported to be less than 10 minutes in duration. Activity was coded as missing if participants reported ≥12 hour per day. The 12-hour per day threshold was based upon limitation of physical activity to leisure-time queries. Participants were then grouped into five subgroups using multivariate finite mixture, in addition to a no-activity group, resulting in a total of six leisure-time physical activity subgroups. The details of this methodology have been described elsewhere) [32].

The Healthy Eating Index (HEI) is a tool developed by the United State Department of Agriculture (USDA) to measure how the diets of Americans comply with the Dietary Guidelines for Americans (DGA). The current HEI score (HEI-2015) ranges from 0-100, with higher scores indicating that overall dietary intake is more consistent with foods and nutrients recommended by the 2015-2020 Dietary Guidelines for Americans [33]. Health-promoting dietary patterns include nutrient-dense foods such as vegetables, fruit, whole grains, low fat dairy or similarly fortified beverages, lean protein foods (seafood, meat, legumes, nuts, seeds and soy), and vegetable oils.

The average HEI score of the U.S. population is currently 59 as measured by the What We Eat in America/National Health and Nutrition Surveys, indicating that U.S. diets are not consistent with DGA [34]. A higher score has been associated with a lower likelihood of CKD development [35].

Statistics

Counts, frequencies and proportions were used to describe the sociodemographic characteristics of the participants within each CKD stage subgroup for continuous and categorical variables, respectively. Chi-square tests were used to identify significant sociodemographic characteristic differences within each CKD stage subgroup. Chi-square tests were also used to assess associations among the CKD stage subgroups with health behaviors and clinical characteristics. Sensitivity analyses were conducted using multiple comparison pairwise chi-square tests with the Bonferroni correction. Statistical significance was set at the alpha level of 0.0033 (0.05/15).

Results

Sample characteristics

The sample included for this analysis totalled 8,489 participants. Survey weights were applied to the sample to ensure national representativeness. The 2003-2004 and 2005-2006 cohorts were similar in age, gender, race/ethnicity, and educational attainment. The mean age for the 2003-2004 cohort was 50.2 (19.2) years and the mean age for the 2005-2006 cohort was 51.5 (19.4) years. Both cohorts were approximately 52% female, 48% male, 52% White, 21% Black, 20% Mexican American, 4% other, and 3% Hispanic. Most of the sample (71%) had a high school degree or higher (Table 1).

As CKD stages increased, ages trended higher, with half of Stage 1 and Stage 2 under 50 years old. Stages 3-5 were all predominantly 60+, though Stage 5 trended younger with far fewer individuals in the 70+ group. Women were overrepresented in Stages 3-4 but there was gender parity in Stages 1, 2, and 5. Looking at racial characteristics, there are a disproportionate number of white individuals with Stages 2-4 and a strong overrepresentation of Black individuals with Stage 5. Those with a high school degree or higher were more likely to have Stages 1-3 while those without a high school degree were more likely to have Stages 4-5.

HEI

In the HEI reporting, 94% of stage 5 CKD participants scored below the 59-point cut-off and 86% in stage 1. While the overwhelming majority still scored below the 59-point cut-off, CKD stages 2-4 fared better than their counterparts in stages 1 and 5.

Physical activity

The vast majority of participants were in physical activity subgroup 1 (no activity) across all stages of CKD. The next highest incidence was found in physical activity subgroup 4 (daily frequency and short duration). The incidence of stage 5 CKD participants in this subgroup was just 1%.

BMI

Over 50% of patients of stage 5 CKD patients have ideal BMIs versus 30% in stage 1. Approximately 30% of stage 1 through 4 were obese, while an additional 30% of stage 1 to 3b were overweight. Less than two percent of all stages were found to be underweight.

	Stage 1	Stage 2	Stage 3a	Stage 3b	Stage 4	Stage 5
Number of participants	3525	4041	624	221	59	19
Age (years)**	a b c d e	a f g h	b f i	c g i j k	d h j l	e k l
21-29	27%	9%	0%	0%	2%	0%
30-39	30%	18%	2%	0%	0%	6%
40-49	27%	22%	8%	3%	1%	14%
50-59	9%	25%	22%	8%	2%	20%
60-69	4%	15%	25%	13%	24%	45%
70+	3%	11%	43%	76%	71%	14%
Gender**	a b	c d	a c	b d		
Female	51%	50%	60%	68%	58%	48%
Male	49%	50%	40%	32%	42%	52%
Race**	a b c	a d e	b f g	c h i	d f h	e g i
Black	17%	7%	6%	9%	15%	42%
Mexican American	14%	5%	2%	1%	4%	7%
Other	7%	5%	4%	3%	8%	0%
Other Hispanic	5%	2%	3%	0%	2%	0%
White	57%	81%	85%	86%	71%	51%
Education**	a b c	a d e f g	d h i	b e h	c f i	g
< High School	21%	14%	20%	32%	37%	46%
High School or greater	79%	86%	80%	68%	63%	54%
Average Hours Worked Per Week**		a b		c d	a c	b d
< 10 Hours	3%	1%	4%	15%	0%	0%
>= 10 Hours	97%	99%	96%	85%	100%	100%
Poverty Income Ratio (PIR)**	a b c d	e f g h	a e	b f	c g	d h
>= 1 (Above the poverty line)	83%	92%	90%	92%	91%	77%
< 1 (Below the poverty line)	17%	8%	10%	8%	9%	23%

Table 1: Socio-demographic characteristics within stages of chronic kidney disease for US Adults (NHANES 2003-2006).

Note: **p < 0.001.

[a b c d e f g h i] Corresponding letters indicate a statistically significant p value <0.0033 (0.05/15) of the multiple comparison pairwise chi-square test using the Bonferroni correction.

Mobility

There was a distinct cut-off in mobility across CKD stages. Greater than 60% of CKD stages 3b-5 participants reported difficulty with mobility. Conversely, greater than 60% denied mobility difficulties in CKD stages 1-3a.

Chronic conditions

Advanced stage CKD (stages 3b-5) had increased incidence of chronic illness. Diabetes and coronary artery disease were greatest in stage 4. Stage 5 CKD boasted the greatest incidence of cancer, congestive heart failure and stroke (Table 2).

Citation: Clark-Cutaia MN, Rivera E, Henstenberg JA, Grunin L, Yu G (2021) Adult Health Behaviors Associated with Chronic Kidney Disease: 2003-2006 NHANES Data. J Nephrol Renal Ther 7: 061.

	Stage 1	Stage 2	Stage 3a	Stage 3b	Stage 4	Stage 5
Number of participants	3525	4041	624	221	59	19
Body Mass Index**	a	b	a b			
Ideal	34%	30%	24%	21%	31%	52%
Obese	33%	34%	35%	38%	39%	25%
Overweight	32%	35%	40%	40%	29%	23%
Underweight	2%	1%	0%	1%	1%	0%
Smokes Cigarettes**	a b c	a d e	b d	c e f		f
Current	32%	22%	11%	6%	14%	42%
Former	19%	28%	37%	42%	38%	30%
Never	49%	50%	52%	52%	48%	29%
Alcohol use**	a b c d e	a f g h i	b f j	c g	d h j	e i
Heavy	11%	8%	4%	4%	0%	0%
Moderate	65%	64%	48%	42%	19%	22%
None	25%	29%	48%	55%	81%	78%
Mobility Problems**	a b c d e	a f g h i	b f j k	c g j	d h k	e i
Any Difficulty	11%	16%	36%	64%	77%	70%
No Difficulty	89%	84%	64%	36%	23%	30%
Physical Activity Cluster**	a b c	d e f g	a d h	b e	c f h	g
No Physical Activity	35%	31%	43%	54%	74%	70%
Low Frequency/ Short Duration	9%	9%	6%	5%	5%	14%
Low Frequency/ Long Duration	5%	5%	3%	3%	0%	2%
Daily Frequency/ Short Duration	34%	36%	37%	33%	20%	1%
Daily Frequency/ Long Duration	4%	5%	4%	2%	1%	6%
High Frequency/ Average Duration	12%	14%	8%	3%	0%	7%
Diabetes**	a b c d e	a f g h	b f i j	c g i	d h j	e
Yes	5%	7%	18%	27%	43%	37%
Borderline	1%	2%	3%	1%	3%	0%
No	94%	91%	79%	72%	53%	63%
Don't know	0%	0%	0%	0%	1%	0%
Congestive Heart Failure**	a b c d e	a f g h i	b f j k l	c g j	d h k	e i l
Yes	1%	2%	9%	19%	36%	37%
No	99%	98%	90%	79%	63%	63%
Don't Know	0%	0%	1%	1%	1%	0%
Coronary Heart Disease**	a b c d	a e f g	b e h	c f h	d g	
Yes	1%	4%	10%	18%	25%	3%
No	99%	96%	89%	81%	72%	97%
Don't Know	0%	0%	1%	2%	3%	0%
Cancer**	a b c d e	a f g h	b f i	c g	d h i	e
Yes	3%	10%	19%	21%	21%	26%
No	97%	90%	81%	79%	75%	74%
Don't Know	0%	0%	0%	0%	4%	0%
Stroke**	a b c d e	a f g h i	b f j k l	c g j	d h k	e i l
Yes	1%	2%	8%	20%	28%	36%
No	99%	98%	92%	79%	72%	64%
Don't Know	0%	0%	0%	1%	0%	0%
Healthy Eating Index**	a b c	a	b	c		
Less than or equal to 59	86%	78%	74%	76%	72%	94%
Greater than 59	14%	22%	26%	24%	28%	6%
Average Time in Bed on the Weekdays**	a b	a	b			
Less than or equal to 7 hours	88%	83%	78%	83%	88%	86%
Greater than 7 hours	12%	17%	22%	17%	12%	14%
Average Time in Bed on the Weekends**	a b c	a d	b e	c f	f g	d e g
Less than or equal to 7 hours	81%	73%	68%	65%	84%	97%
Greater than 7 hours	19%	27%	32%	35%	16%	3%

Table 2: Health behaviors and health outcomes within stages of chronic kidney disease for US Adults (NHANES 2003-2006).

Note: **p < 0.001.

[a b c d e f g h i] Corresponding letters indicate a statistically significant p value < 0.0033 (0.05/15) of the multiple comparison pairwise chi-square test using the Bonferroni correction.

Tobacco and alcohol use

Tobacco use followed a similar trend with over 40% of stage 5 CKD patients describing themselves as current smokers. The lowest rates of current tobacco use were found in stages 2 to 3b. Conversely, advanced stage CKD participants were less likely to consume moderate or heavy amounts of alcohol.

Sleep

The overwhelming majority of the sample reported receiving less than 7 hours of sleep per night. This held true for weekdays and weekend days. Stages 2 to 3b had the lowest proportion of people receiving 7 hours of sleep per night. Again, this remained constant for weekdays and weekend days. See table 2 for Health behaviors and health outcomes within stages of chronic kidney disease for US Adults.

Discussion

HEI scores were overall low in all stages of CKD in the sample population with 72-94% of individuals having scores of ≤59 (the population median). A higher HEI score is associated with lower risk of chronic illness and death [36,37]. In the Atherosclerosis Risk in Communities study, participants in the highest quartile of HEI score had 17% lower risk of developing chronic kidney disease than those in the lowest quartile [35]. Dietary recommendations for patients with chronic kidney disease include increased fruit and vegetable intake for decreased blood pressure and body weight and/or a Mediterranean diet pattern for improved blood lipid levels [38]. Both of these dietary patterns support a higher HEI score; however, they are difficult to implement for individuals who experience food insecurity [39]. Despite federal subsidies such as the Supplemental Nutrition Assistance Programs (SNAP), many patients with low-income do not have the resources to purchase healthful foods in addition to paying for medications, potential hospital visits and transportation to and from their many appointments. Lack of access to nutrient-dense foods and other basic necessities (i.e., food deserts) may contribute to health disparities in chronic kidney disease rates among low-income populations. In addition, a higher BMI is associated with greater survival among patients with CKD. This "obesity paradox" may be due to limitations of BMI as a measure of sarcopenic obesity, which is associated with higher mortality in CKD [40,41].

We observed a decrease in mobility and physical activity in those participants in our sample with stage 4 and 5 CKD. These individuals were also older. Peripheral nerve abnormalities occur early in CKD and progressively worsen over time. CKD is also associated with muscle wasting and loss of strength, or sarcopenia. This, too, progressively worsens with age and disease progression. Physical activity and nutritional therapy are prescribed to mitigate these risks, but patients are likely to have some physical deficits despite this. Just as low-income patients have difficulty accessing sources of healthy food, they may also be limited in their access to safe spaces for exercise [42-44]. Furthermore, there is differential social support and caregiver resources which can be very beneficial in improving diet and exercise adherence [45-48].

These deficits could result in poor mobility and the inability to complete activities of daily living independently. It is impossible to know from these data whether the observed low levels of physical activity are related to the loss of balance, impaired muscle strength, and gait abnormalities common in older adults or if it is CKD-related. It bears mentioning, however, that physical activity has been associated with a reduction in all-cause mortality in CKD patients. For these reasons, physical therapy should be an important element of comprehensive care for individuals with CKD. There is a need for further research in this regard to the type and level of physical activity that can modify advancement of CKD or lower mortality.

Participants in our sample were generally healthy. Advanced stage participants had an increased incidence of diabetes, congestive heart failure, stroke and cardiovascular disease. Multimorbidity and polypharmacy are common in both early and advanced stage CKD, and result in a complex treatment regimen with increased self-management burden. Slowing the deterioration of renal function in advanced CKD patients for whom multimorbidity is common is imperative to reducing adverse outcomes. All CKD patient comorbidities have a negative impact on mortality, cardiovascular disease, hospitalization and length of stay. Quality of life is also negatively impacted. Multimorbidity impacts a patient's ability to access medications and healthful foods, their physical activity and mobility; and sleep. Because these conditions are often so intertwined, it is difficult to determine whether the patient has primary renal disease with comorbidities or renal disease as a result of a comorbid condition. A means to accurately assess the impact of multimorbidity on CKD patients is yet to be determined. The development of such a tool, or one that measures the impact of multimorbidity sequelae such as symptoms, has the potential to inform patient-centered, precision medicine.

Sleep disorders are associated with increased risk of obesity, diabetes, and hypertension, the primary upstream causes of CKD [49]. Additional determinants of sleep disorders include older age, depression, stress and loneliness. Sleep disorders have a profound and well-documented impact on health and quality of life in the general population. In CKD patients, sleep disorders are more prevalent, with an additional morbidity and mortality burden. Low SES and minority race are also risk factors for sleep deficiency [50-57]. There are many sleep disorders associated with CKD. These include, but are not limited to insomnia, obstructive or central sleep apnea, hypoventilation, central disorders of hypersomnolence, circadian rhythm sleep-wake disorders, parasomnias, and sleep-related movement disorders. Our sample was sleeping ≤7 hours each night. Previous studies indicate that short sleep duration (<5 hours) is associated with eGFR decline, while longer duration of sleep (<8 or 9 hours) increases risk for cardiovascular disease and all-cause mortality. Additional work is needed to better understand the associations between different types of sleep disorders and CKD stages.

Data suggests tobacco use has been associated with higher risk of all-cause mortality, while alcohol use has been associated with lower risk of all-cause mortality among patients with CKD. Smoking is another significant risk factor of cardiovascular disease, harbinger of mortality for CKD patients, particularly stage 5 CKD patients. Cardiovascular disease and chronic kidney disease are closely interrelated, and one disease may often develop into or exacerbate the other. As cardiovascular and the deleterious effects of smoking progress in severity in the absence of preventive measures and interventions, older individuals who did not experience those measures when they were younger would present with more advanced stages of cardiovascular disease and smoking damage. As we noted in our sample, older individuals concentrated in the later stages of CKD, and tobacco use was reported highest among the stage 5 CKD patients. Conversely, alcohol use, both moderate and heavy, were highest in the earlier stages of CKD and younger patients. Furthermore, in our sample there is an inverse relationship with alcohol use and adverse outcomes in CKD patients such as proteinuria and low eGFR. Perhaps this, too, is an age-related phenomenon, but remains poorly understood. It is consistent with the inconclusive literature that identified some moderate benefits of alcohol for CKD patients.

Limitations

Our study is not without limitations. First, this secondary data analysis was conducted on cross-sectional data, therefore causal relationships cannot be established, including those pertaining to morbidity or mortality. Second, self-reported data was collected in NHANES 2003-2006 for variables such as sociodemographic characteristics, chronic health conditions, alcohol use, physical activity, and more. Self-reported answers may be unreliable, introducing recall and social desirability biases. Third, this study revealed an increase in the percentage of smokers in the later stages of CKD (3b to 5), yet a corresponding decrease in those who reported having coronary heart disease. It is important to note the number of participants drops significantly in these later stages, which may limit external validity of those results. Lastly, this data was collected approximately 15 years ago. There are many reasons why behaviors may have changed over that span of time. In addition, this has important implications for the formula for the calculation of eGFR at that time. It includes race as a determining factor of eGFR.

Conclusion

Our study demonstrates a need to re-evaluate and perhaps restructure the way in which patients, caregivers, and providers are trained and educated. The literature has consistently demonstrated that there is both low CKD diagnosis awareness on the part of patients and also low adherence to CKD treatment guidelines on the part of providers. Changes to Medicare/Medicaid reimbursement structures could have an impact on provider behavior and subsequent patient awareness and adherence.

Support and Financial Disclosure

This study was not financially supported through funding received by the co-investigators. The authors have disclosed they have no significant relationships with, or financial interest in any commercial companies pertaining to this article.

Acknowledgement

The authors acknowledge the individual contributions of Susan Malone.

References

1. Narva A, Norton JM, Boulware L (2016) Educating Patients about CKD: The Path to Self-Management and Patient-Centered Care. Clin J Am Soc Nephrol 11: 694-703.
2. Schrauben SJ, Hsu JY, Rosas SE, Jaar BG, Zhang X, et al. (2018) CKD Self-management: Phenotypes and Associations With Clinical Outcomes. Am J Kidney Dis 72: 360-370.
3. Chen SH, Tsai YF, Sun CY, Wu IW, Lee CC, et al. (2011) The impact of self-management support on the progression of chronic kidney disease--a prospective randomized controlled trial. Nephrol Dial Transplant 26: 3560-3566.
4. Novak M, Costantini L, Schneider S, Beanlands H (2013) Approaches to self-management in chronic illness. Semin Dial 26: 188-194.
5. Lopez-Vargas PA, Tong A, Howell M, Craig JC (2016) Educational Interventions for Patients With CKD: A Systematic Review. Am J Kidney Dis 68: 353-370.
6. Levin A, Hemmelgarn B, Culleton B, Tobe S, McFarlane P, et al. (2008) Guidelines for the management of chronic kidney disease. CMAJ 179: 1154-1162.
7. Lukela JR, Harrison RV, Jimbo M, Mahallati A, Saran R, et al. (2019) Management of Chronic Kidney Disease. Michigan Medicine, Michigan, USA.
8. Wouters OJ, O'Donoghue DJ, Ritchie J, Kanavos PG, Narva AS (2015) Early chronic kidney disease: Diagnosis, management and models of care. Nat Rev Nephrol 11: 491-502.
9. Blackwell DL, Clarke TC (2018) State variation in meeting the 2008 federal guidelines for both aerobic and muscle-strengthening activities through leisure-time physical activity among adults aged 18-64: United States, 2010-2015. Natl Health Stat Report: 1-22.
10. Dunkley AJ, Bodicoat DH, Greaves CJ, Russell C, Yates T, et al. (2014) Diabetes prevention in the real world: Effectiveness of pragmatic lifestyle interventions for the prevention of type 2 diabetes and of the impact of adherence to guideline recommendations: A systematic review and meta-analysis. Diabetes Care 37: 922-933.
11. Portnoy DB, Scott-Sheldon LA, Johnson BT, Carey MP (2008) Computer-delivered interventions for health promotion and behavioral risk reduction: A meta-analysis of 75 randomized controlled trials, 1988-2007. Prev Med 47: 3-16.
12. Malone SK, Patterson F, Grunin L, Melkus GD, Riegel B, et al. (2021) 2020. Habitual physical activity patterns in a nationally representative sample of U.S. adults. Transl Behav Med 11: 332-341.
13. Silva Junior GB, Bentes AC, Daher EF, Matos SM (2017) Obesity and kidney disease. J Bras Nefrol 39: 65-69.
14. Mc Causland FR, Waikar SS, Brunelli SM (2012) Increased dietary sodium is independently associated with greater mortality among prevalent hemodialysis patients. Kidney Int 82: 204-211.
15. Staplin N, Haynes R, Herrington WG, Reith C, Cass A, et al. (2016) Smoking and Adverse Outcomes in Patients With CKD: The Study of Heart and Renal Protection (SHARP). Am J Kidney Dis 68: 371-380.
16. Ali S, Dave N, Virani SS, Navaneethan SD (2019) Primary and Secondary Prevention of Cardiovascular Disease in Patients with Chronic Kidney Disease. Curr Atheroscler Rep 21: 32.
17. Puddey IB, Mori TA, Barden AE, Beilin LJ (2019) Alcohol and Hypertension-New Insights and Lingering Controversies. Curr Hypertens Rep 21: 79.
18. Polsky S, Akturk HK (2017) Alcohol Consumption, Diabetes Risk, and Cardiovascular Disease Within Diabetes. Curr Diab Rep 17: 136.
19. Marcuccilli M, Chonchol M (2016) NAFLD and Chronic Kidney Disease. Int J Mol Sci 17: 562.
20. Joo YS, Koh H, Nam KH, Lee S, Kim J, et al. (2020) Alcohol Consumption and Progression of Chronic Kidney Disease: Results From the Korean Cohort Study for Outcome in Patients with Chronic Kidney Disease. Mayo Clin Proc 95: 293-305.
21. Ricardo AC, Knutson K, Chen J, Appel LJ, Bazzano L, et al. (2017) The Association of Sleep Duration and Quality with CKD Progression. J Am Soc Nephrol 28: 3708-3715.
22. Lin C-H, Lurie RC, Lyons OD (2020) Sleep Apnea and Chronic Kidney Disease: A State-of-the-Art Review. Chest 157: 673-685.
23. Troiano RP (2007) Large-scale applications of accelerometers: New frontiers and new questions. Med Sci Sports Exerc 39: 1501.
24. Matthews CE, Chen KY, Freedson PS, Buchowski MS, Beech BM, et al. (2008) Amount of time spent in sedentary behaviors in the United States, 2003-2004. Am J Epidemiol 167: 875-881.
25. Van Domelen DR, Pittard WS, Harris TB (2014) nhanesaccel: Process accelerometer data from NHANES 2003-2006.
26. National Cancer Institute (2009) SAS programs for analyzing NHANES 2003–2004 accelerometer data. National Cancer Institute, Maryland, USA.
27. Lauderdale DS, Knutson KL, Yan LL, Liu K, Rathouz PJ (2008) Sleep duration: how well do self-reports reflect objective measures? The CARDIA Sleep Study. Epidemiology 19: 838-845.
28. Hirshkowitz M, Whiton K, Albert SM, Alessi C, Bruni O, et al. (2015) National Sleep Foundation's sleep time duration recommendations: Methodology and results summary. Sleep Health 1: 40-43.
29. Krebs-Smith SM, Pannucci TE, Subar AF, Kirkpatrick SI, Lerman JL, et al. (2018) Update of the Healthy Eating Index: HEI-2015. J Acad Nutr Diet 118: 1591-1602.
30. Reedy J, Lerman JL, Krebs-Smith SM, Kirkpatrick SI, Pannucci TE, et al. (2018) Evaluation of the Healthy Eating Index-2015. J Acad Nutr Diet 118: 1622-1633.
31. Hu EA, Steffen LM, Grams ME, Crews DC, Coresh J, et al. (2019) Dietary patterns and risk of incident chronic kidney disease: The Atherosclerosis Risk in Communities study. Am J Clin Nutr 110: 713-721.
32. Schwingshackl L, Bogensberger B, Hoffmann G (2018) Diet Quality as Assessed by the Healthy Eating Index, Alternate Healthy Eating Index, Dietary Approaches to Stop Hypertension Score, and Health Outcomes: An Updated Systematic Review and Meta-Analysis of Cohort Studies. J Acad Nutr Diet 118: 74-100.

33. Onvani S, Haghighatdoost F, Surkan PJ, Larijani B, Azadbakht L (2017) Adherence to the Healthy Eating Index and Alternative Healthy Eating Index dietary patterns and mortality from all causes, cardiovascular disease and cancer: a meta-analysis of observational studies. J Hum Nutr Diet 30: 216-226.

34. Cases A, Cigarrán-Guldrís S, Mas S, Gonzalez-Parra E (2019) Vegetable-Based Diets for Chronic Kidney Disease? It Is Time to Reconsider. Nutrients 11: 1263.

35. Gregory CA, Mancino L, Coleman-Jensen A (2019) Food Security and Food Purchase Quality Among Low-Income Households: Findings From the National Household Food Acquisition and Purchase Survey (FoodAPS). United States Department of Agriculture, USA.

36. Lavie CJ, De Schutter A, Alpert MA, Mehra MR, Milani RV, et al. (2014) Obesity paradox, cachexia, frailty, and heart failure. Heart Fail Clin 10: 319-326.

37. Park J, Ahmadi SF, Streja E, Molnar MZ, Flegal KM, et al. (2014) Obesity paradox in end-stage kidney disease patients. Prog Cardiovasc Dis 56: 415-425.

38. Wallace D, Chamberlain AW, Fahmy C (2019) Changes in neighborhood social control and disorder and their relationship to exercise behavior. Environment and behavior 51: 717-748.

39. Christian H, Knuiman M, Divitini M, Foster S, Hooper P, et al. (2017) A longitudinal analysis of the influence of the neighborhood environment on recreational walking within the neighborhood: Results from RESIDE. Environ Health Perspect 125: 077009.

40. Maisel JL (2016) Impact of older adults' neighborhood perceptions on walking behavior. J Aging Phys Act 24: 247-255.

41. Sousa H, Ribeiro O, Paúl C, Costa E, Miranda V, et al. (2019) Social support and treatment adherence in patients with end-stage renal disease: A systematic review. Seminars in Dialysis 32: 562-574.

42. Oquendo LG, Asencio JMM, de las Nieves CB (2017) Contributing factors for therapeutic diet adherence in patients receiving haemodialysis treatment: An integrative review. J Clin Nurs 26: 3893-3905.

43. Chen Z, Fan VS, Belza B, Pike K, Nguyen HQ (2017) Association between social support and self-care behaviors in adults with chronic obstructive pulmonary disease. Ann Am Thorac Soc 14: 1419-1427.

44. McDonough MH, Beselt LJ, Daun JT, Shank J, Culos-Reed SN, et al. (2019) The role of social support in physical activity for cancer survivors: A systematic review. Psychooncology 28: 1945-1958.

45. Kazancioğlu R (2013) Risk factors for chronic kidney disease: An update. Kidney Int Suppl 3: 368-371.

46. Rottapel RE, Zhou ES, Spadola CE, Clark CR, Kontos EZ, et al. (2020) Adapting sleep hygiene for community interventions: A qualitative investigation of sleep hygiene behaviors among racially/ethnically diverse, low-income adults. Sleep Health 6: 205-213.

47. Perales F, Plage S (2017) Losing ground, losing sleep: Local economic conditions, economic vulnerability, and sleep. Soc Sci Res 62: 189-203.

48. Tomfohr LM, Ancoli-Israel S, Dimsdale JE (2010) Childhood socioeconomic status and race are associated with adult sleep. Behav Sleep Med 8: 219-230.

49. Goosby BJ, Straley E, Cheadle JE (2017) Discrimination, sleep, and stress reactivity: Pathways to African American-White cardiometabolic risk inequities. Population Research and Policy Review 36: 699-716.

50. Wang Y, Yip T (2019) Sleep facilitates coping: Moderated mediation of daily sleep, ethnic/racial discrimination, stress responses, and adolescent well-being. Child Dev 91: 833-852.

51. Choi DW, Chun SY, Lee SA, Han KT, Park EC (2018) Association between sleep duration and perceived stress: Salaried worker in circumstances of high workload. Int J Environ Res Public Health 15: 796.

52. Wong K, Chan AHS, Ngan SC (2019) The effect of long working hours and overtime on occupational health: A meta-analysis of evidence from 1998 to 2018. Int J Environ Res Public Health 16: 2102.

53. Arenas DJ, Thomas A, Wang J, DeLisser HM (2019) A systematic review and meta-analysis of depression, anxiety, and sleep disorders in US adults with food insecurity. J Gen Intern Med 34: 2874-2882.

54. Fan Z, Yun J, Yu S, Yang Q, Song L (2019) Alcohol consumption can be a "double-edged sword" for chronic kidney disease patients. Med Sci Monit 25: 7059-7072.

55. Althubaiti A (2016) Information bias in health research: Definition, pitfalls, and adjustment methods. J Multidiscip Healthc 9: 211-217.

56. Sperati CJ, Soman S, Agrawal V, Liu Y, Abdel-Kader K, et al. (2019) Primary care physicians' perceptions of barriers and facilitators to management of chronic kidney disease: A mixed methods study. PloS One 14: 0221325.

57. Chen TK, Knicely DH, Grams ME (2019) Chronic kidney disease diagnosis and management: A review. JAMA 322: 1294-1304.