UNIVERSITY OF MANITOBA | MAX RADY COLLEGE OF MEDICINE
Rady Faculty of Health Sciences

Bachelor of Science in Medicine Degree Program
End of Term Final Report

Office of Graduate and Advanced Degrees Education in Medicine Max Rady College of Medicine
Rady Faculty of Health Sciences
University of Manitoba

Student Name: Kelsey Connelly

Date: August 5, 2018

Project Title:
Frailty and physical function in chronic kidney disease (CanFIT) study: The Impact of Physical Activity on Health Outcomes

Primary Supervisor Name: Dr. Navdeep Tangri
Department: Seven Oaks Nephrology

Co-Supervisor Name:
Department:

Summary (250 words max single spaced):

Chronic kidney disease (CKD) disproportionately affects more than one third of the geriatric population, and is known to be associated with a decline in physical function. In the general population, reduction in physical activity level can have detrimental effects on quality of life and is known to be associated with an increased risk of all-cause mortality. Though widely studied in dialysis patients, relatively little is know about the associations between physical activity and poor outcomes in pre-dialysis patients with CKD.
We conducted a prospective cohort study including 592 patients with CKD stages G4-G5. Physical activity was assessed using the Physical Activity Scale for the Elderly (PASE) and scores were separated into tertiles: 0-40 (low physical activity), 41-90 (light physical activity), and more than 90 (moderate to high physical activity). We investigated the association between differing physical activity levels and the outcomes of death, progression to dialysis, and future falls.
When compared low physical activity, higher levels of physical activity were associated with a 44% reduction in all-cause mortality. We found no association between higher levels of physical activity and reduction in progression to dialysis, as well as reduction in future falls.
Our study indicates the importance of physical activity assessments in CKD patients. Such clinical implementation will allow for patients to avoid poor outcomes associated with kidney failure. The longitudinal trajectory of physical activity and its association with progression to dialysis and future fall risk requires further studies.

Student Signature

Primary Supervisor Signature
Navdeep Tangri
Digitally signed by Navdeep Tangri
DN: cn=Navdeep Tangri, o=Seven Oaks General Hospital, ou=Chronic Disease Innovation Centre, email=ntangri@sogh.mb.ca, c=CA
Date: 2018.08.03 15:17:57 -05'00'

Acknowledgments: I gratefully acknowledge the sole or partial funding support from:

H.T. Thorlakson Foundation
Dean, College of Medicine
Research Manitoba

Manitoba Medical Service Foundation (MMSF)
Vice-Dean, Research Rady FHS
Health Sciences Centre Research Foundation
Heart and Stroke Foundation

Sponsorship if different than above;

INTRODUCTION

Globally, chronic kidney disease (CKD) is one of the fastest growing chronic diseases[1]. CKD disproportionately affects the elderly (>65 years of age), with more than one third of the geriatric population having some degree of CKD[2]. As a result, the burden of CKD will further increase as the geriatric population continues to grow[3]. In this population, CKD is known to be associated with adverse health outcomes, including significant loss of physical and cognitive function[4].

When compared to an age-matched population control, patients with CKD have lower levels of physical activity[5]. This sedentary lifestyle is known to worsen the severity of CKD, resulting in increased risk of falls, decreased tolerance towards dialysis-related side effects, and decreased quality of life[5-7]. Studies have also indicated that low levels of physical activity can lead to a 1.5- to 2-fold increased risk in hospitalizations and mortality rates in the CKD population[8-12].

For CKD patients, especially those undergoing dialysis, it has been found that light to moderate physical activity may confer some benefit in combating all-cause mortality[13-15]. However, studies have yet to determine whether or not physical activity in pre-dialysis CKD patients could aid in delaying the need for dialysis. It is important to address this question as the mortality rate among dialysis patients is very high, despite ongoing advancements in the field[13].

Falls are common amongst the elderly, with and without CKD, and have been known to cause serious injury or death[16,17]. Several studies have looked at the association between CKD and falls, indicating that these patients, specifically those on dialysis, have a greater chance of falling and developing fall-related complications than those without CKD[18]. Various factors have been looked at in order to determine why this relationship exists, including eGFR, ACR, and polypharmacy[19,20]. However, the association between physical activity in CKD patients and falls has yet to be looked at extensively, and thus could potentially provide a window of intervention used in reducing risk of falls.

In order to determine the association of physical activity with poor health outcomes in a CKD population, we performed a longitudinal analysis on patients from the The Canadian Frailty Observation and Interventions Trial (CanFIT) study using the Physical Activity Scale for the Elderly (PASE). We hypothesized that CKD patients with a marked decrease in self-reported physical activity levels would experience poorer health outcomes (risk of falls, progression to dialysis, and death) when compared to those with higher levels of physical activity.

MATERIAL AND METHODS

Design and Population

CanFIT is a multicenter prospective cohort study of frailty, physical function, and cognitive ability in patients with advanced CKD. The study began enrolling participants in 2012 at four Canadian multidisciplinary renal health clinics, including Seven Oaks General Hospital, St. Boniface General Hospital, and the Health Sciences Centre in Winnipeg, MB as well as the Kidney Health Centre in Regina General Hospital in Regina, SK. The study was designed to collect data from 600 patients over 2 years with a baseline assessment followed by annual assessments. The present discussion utilizes data collected from the baseline assessment of the first 592 patients enrolled in the CanFIT study. Individuals included in the study are patients with CKD Stages G4-G5 attending one of the above renal health clinics. Exclusion criteria include inability to provide informed consent, inability to speak English, blindness, known dementia and previous dialysis treatment. Ethics approval was obtained from the University of Manitoba Health Research Board as well as the St. Boniface General Hospital Research Review Committee and the Regina Qu'Appelle Health Region Research Ethics Board. Informed consent was obtained from each study participant.

Assessment of Physical Activity

Self-reported physical activity is assessed at each study visit using the PASE. The PASE was designed to measure physical activity levels in the elderly (>65 years old) and includes questions about occupational, household, and leisure activities performed during the last 7 days[21,22]. Leisure activities such as, walking outside the home, light, moderate, and strenuous sport and recreation and muscle strengthening were recorded as never, seldom (1-2 days/week), sometimes (3-4 days/week), and often (5-7 days/week) performed. The duration for each activity per day was coded as i) Less than 1 hour, ii) Between 1 and 2 hours, iii) 2 to 4 hours or iv) More than 4 hours. Household activities were recorded as yes = 1 and no = 0. Occupational activities that was paid or voluntary was recorded in the total hours per week, unless this activity involved only sitting. The total score is then calculated by multiplying the total time spent per week or participation (yes/no) by the weighted score assigned to each activity and summed across all activity items[21]. Based on previous literature we stratified PASE scores into tertiles: 0-40 (low physical activity), 41-90 (light physical activity), and more than 90 (moderate to high physical activity)[23]. Chart reviews were conducted to confirm and identify further comorbidities and record laboratory data.

Statistical Analysis

Descriptive statistics were stratified by their PASE score using the T-test and Mann-Whitney U test when appropriate for continuous variables and the Chi-squared test for categorical variables.)The association between each PASE tertile and outcomes of death, dialysis, and falls were evaluated with Cox proportional hazards models. Each PASE tertile was evaluated separately as a predictor of the study outcomes in three models. The first is an unadjusted model, the second adjusted for age and sex, and the third adjusted for age, sex and various comorbidities/lab values obtained at baseline assessment. All analyses were done using SAS 9.3.

RESULTS

Study Population

In the CanFIT study, 592 participants completed baseline self-reported PASE assessments included in the study. Chart reviews were conducted to collect clinical characteristics and comorbidities at baseline. Median age was higher in the low physical activity group (77.12 years compared to 73.99 and 65.54 in the light and moderate to high physical activity groups) (Table 1). The moderate to high physical activity group had a lower prevalence of almost all comorbidities when compared to those with low and light physical activity, with the exception of type I diabetes and neurological disease. The moderate to high physical activity group also reported less falls (Table 1). Hypertension was prevalent at a high rate despite differing levels of physical activity. Weight, height, blood pressure, and the various lab values were similar across all levels of physical activity.

Association of Physical Activity Level with Death

The association between physical activity level and death is presented in Table 2. In both unadjusted and adjusted for age and sex models, higher levels of physical activity were associated with a decrease in mortality. The unadjusted moderate to high physical activity group was found to have the greatest effect in combating mortality, with patients in this group being 69% less likely to die than patients in the low physical activity group (HR 0.31 [95% CI: 0.19-0.50]). The unadjusted light physical activity group also had a reduced risk of mortality, with patients in this group being 44% less likely to die than patients in the low physical activity group (HR 0.56 [95% CI: 0.37-0.85]). Our model adjusted for age, sex, CHF, CVD, diabetes, arthritis, eGFR, hemoglobin and serum albumin, the moderate to high physical activity group had a significant association with reduced mortality (HR 0.56 [95% CI: 0.33-0.94]), while the light physical activity group did not remain statistically significant (HR 0.77 [95% CI: 0.50-1.20]).

Association of Physical Activity Level with Progression to Dialysis

The association between physical activity level and progression to dialysis is presented in Table 3. Although not significant, age, sex, CHF, CVD, diabetes, arthritis, eGFR, hemoglobin and serum albumin, the moderate to high physical activity group was associated with an increase in progression to dialysis when compared to the low physical activity group (HR 1.40 [95% CI: 0.93-2.12]). This relationship was also seen when comparing the light physical activity group to the low physical activity group, but to a lesser degree (HR 1.29 [95% CI: 0.86-1.92]). However, the moderate to high physical activity group, when adjusted for age and sex only, diverged from this trend and was statistically significant (HR 0.61 [95% CI: 0.42-0.88]).

Association of Physical Activity Level with Falls

The association between physical activity level and falls as an outcome is presented in Table 4. Before and after adjusting for age, sex, and comorbidities/lab values, as well as previous falls, there was no association between physical activity levels and falls. Previous falls in the last 12 months was found to be independently associated with future falls.

DISCUSSION

When compared to an age-matched control group, patients with CKD have lower overall levels of physical activity[5]. In this prospective cohort study of 592 individuals with advanced CKD, we found an association between moderate to high physical activity levels and reduction in all-cause mortality. This finding alone supports the need for maintained or increased physical activity in patients at any stage of CKD. This study also determined that physical activity levels measured at baseline were not associated with progression to dialysis and future risk of falls.

To our knowledge, this is the first study to look at the use of self-reported physical activity in predicting poor outcomes for CKD patients. The PASE was used for measuring physical activity in our study and has been studied for its use as a prognostic factor in natural aging and mortality of the elderly[23,24]. In one prospective cohort study using 500 elderly (>=85 years old) patients, it was found that PASE was a predictor of mortality and functional status. The study also noted the significance of PASE, as it was the only modifiable predictor of survival, where a 10-point increase in PASE score corresponds to a 10% reduction in 7-year mortality[24]. In another study, it was found that older adults who scored lower on PASE were more likely to develop sarcopenia as they aged[23]. This is relevant to our study population, as sarcopenia is a major consequence of CKD and often results in a further reduction in physical activity[25].

As mentioned above, this study concluded that moderate to high physical activity levels were independently associated with reduction in all-cause mortality in CKD patients. Previous studies have found an association between low physical activity levels and an increase all-cause mortality, for both CKD and non-CKD patients alike[26]. However, this appears to be a much larger issue for those with CKD than those without the disease. In one study, a multivariate logistic regression model was used to compare physical activity levels in non-CKD individuals to those with CKD. They discovered that there was a higher prevalence of physical inactivity (OR, 1.30 [95% CI: 1.03-1.64]) in the CKD population, concluding that the likelihood of all-cause mortality was much higher in the CKD population[8]. For the purposes of our study, cause of death was not assessed when a patient had achieved mortality as the outcome.

We found that higher baseline physical activity was not associated with a decrease in progression to dialysis when compared to those with low physical activity. While the negative affect of dialysis on physical activity levels has been looked at extensively, to our knowledge the opposite has not been studied[12]. One possible reason for this lack of association found in our study is that the patients included in the study had already reached advanced stages of CKD (G4-G5). Since the degree of CKD in these patients has already progressed a substantial amount, the need for dialysis is likely inevitable and thus, the role physical activity was inconsequential in changing their outcome. Another possible reason for the lack of an association may be that patients with moderate to high levels of physical activity end up receiving dialysis because they are younger and live longer. As discussed before, physical activity is known to have a reduction in mortality in both CKD and non-CKD patients[26]. The patients who fall into this category of high physical activity were much younger on average than those who had low levels of physical activity (Table 1). This likely means they will have much more time to progress towards the advanced stages of CKD than those who are older when they were first assessed at baseline. The association between longevity and dialysis need has already been seen on a global scale, as the incidence of kidney failure in the geriatric population (75 years and older) has increased at a rate of 37% since 2000[27].

We also found that there was no association between higher baseline physical activity and reduction in future fall risk. As was the case for progression to dialysis, to our knowledge, the ability to predict future fall risk in patients with CKD from a baseline physical activity assessment has not been studied. While this study found no association between higher levels of physical activity and reduction in falls, it was found that previous falls prior to baseline have an independent association with future falls. This finding has been supported by another study, which found that the majority (57%) of dialysis patients who had a previous fall had a subsequent fall within the following 12 months[17]. While there is a lack of studies looking at the association between falls and physical activity in the CKD population, there have been various studies that have looked at the association in the geriatric population. One prospective cohort study of 1,011 participants, ages 75 and older, investigated whether physical activity was associated with the risk of falls. Using PASE to assess physical activity, they found that patients who scored in the high physical activity range (PASE score >79.9) had the highest risk of falls[28]. While it is important, as we have shown, for CKD patients to maintain moderate to high levels of physical activity, it is also important to consider the risk of falls when doing physical activity[29]. This may require that the method of physical activity be modified to one that is less dependent on the individual moving around or one requiring supervision, thereby decreasing the risk of falls.

One of the primary strengths of this study is that it is a large and unique cohort. As we have mentioned, studies looking at the association between physical activity and poor outcomes for patients with CKD are lacking and is an area that requires further investigation. A second strength of this study is the use of PASE, which is a validated and non-invasive tool for assessing physical activity[21,22]. However, the nature of this tool is that it is based on self-reporting for measuring physical activity. Since it is not an objective measurement and requires patients to recall a weeks' worth of physical activity, it may result in over- or under-reporting of true physical activity. In order to get a more objective measurement of physical activity, the use of accelerometers may be advantageous and could allow for stronger associations to be found.

This study has multiple clinical implications that could be helpful in preventing the previously mentioned poor outcomes in CKD patients. The first is the early intervention of moderate to high physical activity in these patients; physical activity should be promoted to these patients. Exercise training has already been shown to not only improve physical activity levels in CKD patients, but also has been shown to improve patient frailty, which is another issue in the CKD population[30]. Another implication is that current physical activity levels of patients need to be assessed by their physicians. This knowledge will allow for an understanding of which course of treatment is best suited for individual patients, as well as helping set goals for the patient in terms of their physical activity levels. The questioning of the history of falls is also important as this will help tailor what types of physical activities the patient is capable of without having the risk of falling. The use of occupational therapy and gait speed analysis could also prove vital in decision making about the patients physical activity capacity[31].

CONCLUSION

Higher levels of physical activity are found to have an association with reduction in all-cause mortality in the CKD population. While this was the only outcome significantly associated with higher physical activity in this study, further research is still needed to investigate the association with progression to dialysis need and future fall risk. The use of PASE in assessing physical activity levels is a practical and validated tool, and should be used to assess patient's physical activity when beginning treatment for CKD.

Table 1: Baseline characteristics of the study cohort

Characteristics	PASE Score			P-value
	Low **0-40 (n=140.4)**	**Light** **41-90 (n=204)**	**Moderate-High** **>90 (n=247.6)**	
Anthropometric Data				
Age (years)	77.12 (69.23-85.10)	73.99 (66.58-82.75)	65.54 (55.71-75.75)	<.0001
Weight (kg)	86.80 (72.40-105.00)	80.60 (69.90-96.60)	85.00 (72.70-97.70)	<.0001
Height (cm)	168.91 (162.56-175.26)	167.00 (159.20-175.26)	170.18 (162.56-177.80)	<.0001
Systolic Blood Pressure (mmHg)	138.00 (124.00-151.00)	138.00 (124.00-150.00)	134.00 (122.00-150.00)	0.0126
Diastolic Blood Pressure (mmHg)	69.00 (64.00-78.00)	73.00 (64.00-82.00)	77.00 (68.00-85.00)	<.0001
Hemoglobin (g/L)	111.00 (100.00-124.00)	114.00 (105.00-126.00)	116.00 (107.00-126.00)	<.0001
Creatinine (μmol/L)	280.00 (207.00-354.00)	237.00 (191.00-348.00)	281.00 (209.00-345.00)	<.0001
Estimated Glomerular Filtration Rate (mL/min/1.73m^2)	18.00 (13.00-24.00)	20.00 (14.00-26.00)	19.00 (14.00-25.00)	0.0024
PASE	25.00 (2.20-30.61)	61.97 (52.20-76.16)	141.71 (111.80-187.00)	<.0001
Comorbidities (%)				
Arthritis	45.73	47.55	33.60	<.0001
Depression	20.09	18.14	14.05	0.0013
Malignancy	22.22	20.10	18.34	0.1163
Myocardial Infarction	27.78	17.65	18.17	<.0001
Angioplasty	7.12	6.86	6.06	0.6018
Cardiac	19.94	9.80	9.29	<.0001
Diabetes II	70.09	60.29	46.04	<.0001
Diabetes I	1.71	4.12	6.70	<.0001

Characteristics	PASE Score			P-value
	Low 0-40 (n=140.4)	Light 41-90 (n=204)	Moderate-High >90 (n=247.6)	
Hypertension	90.74	88.73	82.47	<.0001
Peripheral Vascular Disease	14.96	14.71	9.29	<.0001
Stroke	9.26	7.84	6.95	0.1889
Cardiovascular Disease	11.40	8.33	4.44	<.0001
Neurological	0.71	1.96	1.29	0.0872
Congestive Heart Failure	22.79	8.82	5.65	<.0001
Falls in last 12 months	31.47	30.65	20.10	0.74

Table 2: Association between physical activity level and mortality

	Hazard Ratio	Confidence Intervals	P-Value
Physical Activity Level			
Low	Ref	Ref	Ref
Light			
Model 1[a]	0.56	0.37-0.85	0.007
Model 2[b]	0.64	0.42-0.98	0.04
Model 3[c]	0.77	0.50-1.20	0.25
Moderate-High			
Model 1[a]	0.31	0.19-0.50	<.0001

Model 2[b]	0.42	0.26-0.69	0.0005
Model 3[c]	0.56	0.33-0.94	0.03

[a]Unadjusted Cox Model

[b]Adjusted Cox Model for Age & Sex

[c]Adjusted Cox Model for Age, Sex, CHF, CVD, Diabetes, Arthritis, eGFR, Hemoglobin, Serum Albumin

Table 3: Association between physical activity level and dialysis

	Hazard Ratio	**Confidence Intervals**	**P-Value**
Physical Activity Level			
Low	Ref	Ref	Ref
Light			
Model 1[a]	0.88	0.61-1.28	0.50
Model 2[b]	0.78	0.53-1.13	0.19
Model 3[c]	1.29	0.86-1.92	0.21
Moderate-High			
Model 1[a]	0.93	0.66-1.32	0.70
Model 2[b]	0.61	0.42-0.88	0.009
Model 3[c]	1.40	0.93-2.12	0.11

[a]Unadjusted Cox Model

[b]Adjusted Cox Model for Age & Sex

[c]Adjusted Cox Model for Age, Sex, CHF, CVD, Diabetes, Arthritis, eGFR, Hemoglobin, Serum Albumin

Table 4: Association between physical activity level and falls

	Hazard Ratio	Confidence Intervals	P-Value
Physical Activity Level			
Low	Ref	Ref	Ref
Light			
Model 1[a]	0.94	0.60-1.47	0.22
Model 2[b]	0.96	0.61-1.50	0.84
Model 3[c]	1.07	0.67-1.72	0.77
Moderate-High			
Model 1[a]	0.75	0.47-1.18	0.79
Model 2[b]	0.80	0.49-1.29	0.35

Model 3[c]	0.84	0.51-1.41	0.51

[a]Unadjusted Cox Model

[b]Adjusted Cox Model for Age & Sex

[c]Adjusted Cox Model for Age, Sex, CHF, CVD, Diabetes, Arthritis, eGFR, Hemoglobin, Serum Albumin, Previous Falls

REFERENCES

1. Foundation NK. K/DOQI clinical practice guidelines for chronic kidney disease: evaluation, classification, and stratification. Am J Kidney Dis. 2002; 39:S1–S266. [PubMed: 11904577]

2. Coresh J, Selvin E, Stevens LA, Manzi J, Kusek JW, Eggers P, et al. Prevalence of chronic kidney disease in the United States. JAMA. 2007;298(17):2038–47.

3. Jha V, Garcia-Garcia G, Iseki K, et al. Chronic kidney disease: global dimension and perspectives. Lancet. 2013;382(9888):260-272.

4. Plantinga, L. C., Johansen, K., Crews, D. C., Vahakn, B., Robinson, B. M., Saran, R., & Burrows, N. R. (2012). NIH Public Access, 57(2):212–227.

5. Beddhu S, Baird BC, Zitterkoph J, Neilson J, Greene T. Physical activity and mortality in chronic kidney disease (NHANES III). Clin J Am Soc Nephrol. 2009;4(12):1901-1906.

6. Johansen KL, Kaysen GA, Dalrymple LS, et al. Association of physical activity with survival among ambulatory patients on dialysis: the Comprehensive Dialysis Study. Clin J Am Soc Nephrol. 2013;8(2):248-253.

7. Johansen KL, Chertow GM, Kutner NG, Dalrymple LS, Grimes BA, Kaysen GA. Low level of self-reported physical activity in ambulatory patients new to dialysis. Kidney Int. 2010;78(11):1164-1170.

8. Beddhu S, Baird BC, Zitterkoph J, Neilson J, Greene T. Physical activity and mortality in chronic kidney disease (NHANES III). Clin J Am Soc Nephrol. 2009;4:1901-1906.

9. DeOreo PB. Hemodialysis patient-assessed functional health status predicts continued survival, hospitalization, and dialysis- attendance compliance. Am J Kidney Dis. 1997;30:204-212.

10. Stack AG, Molony DA, Rives T, Tyson J, Murthy BV. Association of physical activity with mortality in the US dialy- sis population. Am J Kidney Dis. 2005;45:690-701.

11. Kurella Tamura M, Covinsky KE, Chertow GM, Yaffe K, Landefeld CS, McCulloch CE. Functional status of elderly adults before and after initiation of dialysis. N Engl J Med. 2009;361:1539-1547.

12. Johansen KL, Kaysen GA, Dalrymple LS, et al. Association of physical activity with survival among ambulatory patients on dialysis: the Comprehensive Dialysis Study. Clin J Am Soc Nephrol. 2013;8:248-253.

13. Matsuzawa R, Matsunaga A, Wang G, et al. Habitual physical activity measured by accelerometer and survival in maintenance hemodialysis patients. Clin J Am Soc Nephrol. 2012;7(12):2010-2016.

14. Beddhu S, Wei G, Marcus RL, Chonchol M, Greene T. Light-Intensity Physical Activities and Mortality in the United States General Population and CKD Subpopulation. Clin J Am Soc Nephrol. 2015;10(7):1145-1153.

15. Robinson-Cohen C, Littman AJ, Duncan GE, et al. Physical Activity and Change in Estimated GFR among Persons with CKD. J Am Soc Nephrol. 2014;25(2):399-406.

16. Tinetti ME, Speechley M. Risk factors for falls among elderly persons. N Engl J Med. 1988;319{Demiri(26):1701. http://ezproxy.lib.swin.edu.au/login?url=http://search.ebscohost.com/login.aspx?direct=true&db=hch&AN=8901160217&site=ehost-live&scope=site.

17. Cook WL, Tomlinson G, Donaldson M, et al. Falls and fall-related injuries in older dialysis patients. Clin J Am Soc Nephrol. 2006;1(6):1197-1204.

18. Cook WL, Jassal SV. Prevalence of falls among seniors maintained on hemodialysis. Int Urol Nephrol. 2005;37(3):649-652.

19. Bowling CB, Bromfield SG, Colantonio LD, et al. Association of reduced eGFR and albuminuria with serious fall injuries among older adults. Clin J Am Soc Nephrol. 2016;11(7):1236-1243.

20. Woolcott JC, Richardson KJ, Wiens MO, et al. Meta-analysis of the impact of 9 medication classes on falls in elderly persons. Arch Intern Med. 2009;169(21):1952-1960.

21. Washburn R, Smith K, Jette A, Janney C. The Physical Activity Scale for the Elderly (PASE): development and evaluation. J Clin Epidemiol. 1993; 46:153–162.

22. Washburn R, Ficker J. Physical Activity Scale for the Elderly (PASE): the relationship with activity measured by a portable accelerometer. J Sports Med Phys Fitness. 1999; 39:336–340.

23. Curcio F, Liguori I, Cellulare M, et al. PASE (Physical Activity Scale for the Elderly) Score Is Related to Sarcopenia in Noninstitutionalized Older Adults. J Geriatr Phys Ther. 2017:1.

24. Muscari A, Bianchi G, Forti P, et al. Physical Activity and Other Determinants of Survival in the Oldest Adults. J Am Geriatr Soc. 2017;65(2):402-406.

25. Studenski S, Perera S, Patel K, et al. Gait speed and survival in older adults. JAMA. 2011;305(1):50-58.

26. Schmid D, Ricci C, Leitzmann MF. Associations of objectively assessed physical activity and sedentary time with all-cause mortality in US adults: the NHANES study. PLoS One. 2015;10(3):e0119591.

27. US Renal Data System (USRDS): Annual Data Report. Atlas of End-Stage Renal Disease in the United States. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases, 2011.

28. Lewis ZH, Markides KS, Ottenbacher KJ, Snih S Al. The role of physical activity and physical function on the risk of falls in older Mexican Americans. J Aging Phys Act. 2016;24(3):342-349.

29. Bohm C, Stewart K, Onyskie-Marcus J, Esliger D, Kriellaars D, Rigatto C. Effects of intradialytic cycling compared with pedometry on physical function in chronic outpatient hemodialysis: a prospective randomized trial. Nephrol Dial Transplant. 2014;29(10):1947-1955.

30. Heiwe S, Jacobson SH. Exercise training for adults with chronic kidney disease. Cochrane Database Syst Rev. 2011;10:CD003236.

31. Roshanravan B, Robinson-Cohen C, Patel K V, et al. Association between physical performance and all-cause mortality in CKD. J Am Soc Nephrol. 2013;24(5):822-830.