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The Association of Daily Activity Levels and Estimated Kidney Function in Men and Women With Predialysis Chronic Kidney Disease

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Introduction: Chronic kidney disease (CKD) is often accompanied by complications including poor physical activity level. However, only a few studies have objectively characterized physical activity levels in predialysis CKD. Our study sought to measure daily activity levels by accelerometry in individuals with CKD (stages III−V) and to determine the association between daily activity and kidney function.

Methods: We determined kidney function by means of the estimated glomerular filtration rate (eGFR) using the Modification of Diet and Renal Disease (MDRD) equation. Participants wore an accelerometer for 7 consecutive days, and we measured multiple physical activity outcomes including total daily activity, sedentary, light, and moderate−vigorous activity. Average durations and intensity of activity were determined according to stage of CKD. The association between kidney function and activity level was determined by regression analysis.

Results: We analyzed data from 110 individuals (60% men and 40% women) with stages III to V CKD. The mean age of our participants was 64 years, mean body mass index was 27.5 kg/m^2, and mean eGFR was 23.7 $\pm$ 1.2 ml/min/1.73 m^2. Our participants were primarily sedentary (mean duration of inactivity = 1152 $\pm$ 100 minutes per day; 79% of day). Light activity was performed 280 $\pm$ 99 minutes per day, and individuals participated in only 6 $\pm$ 9 minutes per day of moderate−vigorous activity. The eGFR did not predict physical activity level ($P > 0.05$ for all).

Discussion: Individuals with stages III to V CKD are sedentary, and do not meet the national recommendations of 150 minutes of moderate−vigorous activity per week. Further study is required to determine whether interventions to increase activity levels in patients with CKD are associated with improved health outcomes.

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Chronic kidney disease (CKD) is an increasingly prevalent condition[1,2] that is associated with significant morbidity and mortality.[3–5] One important complication of CKD is impaired musculoskeletal health. CKD is associated with fatigue, muscle cramps, weakness, and low energy.[6,7] These symptoms begin early in predialysis CKD and progress over time as kidney function decreases to end-stage kidney failure,[8,9] and may contribute to decreased participation in physical activity. Poor participation in moderate−vigorous physical activity is associated with multiple health risks including obesity, cardiovascular disease, metablic syndrome, and type 2 diabetes.

The first step in determining whether improving physical activity levels in individuals with CKD is necessary is to objectively measure how active or inactive they may be. If reduced kidney function is associated with poor physical activity levels in men and women with predialysis CKD, it may be important to target CKD stage−appropriate exercise interventions before the initiation of dialysis therapy to preserve or enhance outcomes such as musculoskeletal and cardiovascular health. To date, only a few studies have characterized physical activity in individuals with

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predialysis CKD using accelerometry (an objective measure of physical activity),[10–12] and only 1 of these studies evaluated the association between kidney function and physical activity.[10] Hawkins *et al*. reported that the total amount of physical activity performed was positively associated with better kidney function[10]; however, only individuals with an estimated glomerular filtration rate (eGFR) of > 30 ml/min (CKD stages I−III) were included, and those with more advanced predialysis CKD stages IV−V (eGFR ≤ 30 ml/min) were excluded.

Therefore, the purposes of our study were (i) to characterize daily activity levels by accelerometry in individuals with stages III to V predialysis CKD, and (ii) to determine the association between total daily activity, sedentary, light, and moderate−vigorous activity and kidney function in individuals with stages III to V CKD. We hypothesized that those with stage III to V CKD would be inactive, and that better kidney function would be associated with greater physical activity levels.

MATERIALS AND METHODS

Study Participants

We enrolled 122 participants aged 18 years and older from predialysis CKD clinics in Toronto, Ontario, Canada. The majority of participants (88%) were recruited from the Renal Management Clinic at the University Health Network, a multidisciplinary tertiary care clinic for men and women with CKD. All participants were diagnosed with having CKD by a nephrologist, and provided written informed consent to participate. All appropriate institutional review boards approved the study.

Accelerometry

We assessed daily activity by accelerometry using a triaxial activity monitor (i.e., measures movement on 3 axes [X, Y, Z]; StayHealthy, RT3) worn on the participant's left hip for 7 consecutive days. Participants were instructed to wear the monitor during all waking hours, and to remove the monitor only to sleep, shower, or partake in water-based activities. Participants kept a log of when they wore or removed the monitor, and when purposeful physical activity (i.e., exercise) was performed. It should be noted that we did not exclude sleep time (i.e., when the monitor was removed for recorded sleep) in our analysis because of the possibility that our participants were sleeping more due to fatigue associated with CKD. We wanted to evaluate overall activity level in a 24-hour period, and not only activity level during awake time.

RT3 minute-by-minute data were evaluated and compared to those in the monitor logs when necessary for each participant. RT3 data were divided into 24-hour periods from the time that the participant began wearing the monitor. When a block of time ≥ 60 minutes of consecutive zeros was identified within a 24-hour period of RT3 wear, this data point was examined more carefully. Within a 24-hour period, "no wear time" > 4 hours that was unaccounted for would void the 24-hour collection period. Participants with a minimum of 4 days of valid data were included in the analyses[10] because, in adults, 3 to 5 days of wear time are required to reliably estimate daily physical activity.[13]

To determine average total kilocalories (kcals) expended per day, the activity in kcal per minute for each minute of a valid 24-hour collection period was summed and divided by the number of valid days of wear time to estimate average total daily activity kcal expenditure for each participant. Intensity of daily activity was determined using previously validated cut points for the RT3.[14] Each minute of accelerometry data for all participants was coded by intensity level. A minute of accelerometer data was coded as sedentary behavior if the vector magnitude (unit-less activity count produced by the RT3) was between 0 and 100 counts[10]; as light intensity if the vector magnitude was between 100 and 1772[14] (equivalent to up to 3.9 metabolic equivalents [METs], which include activities such as washing dishes and cooking [3.3 METs], vacuuming [3.3 METs], mopping [3.5 METs], and walking for pleasure [3.5 METs][15]); and as moderate−vigorous intensity (≥ 4 METs, which include activities such as leisurely bicycling [6.0 METs], shoveling snow [6.0 METs], and carrying groceries upstairs [7.5 METs][15]) if the vector magnitude was ≥ 1772 counts.[14] Each minute of sedentary, light, and moderate−vigorous activity was summed separately and divided by the number of valid days of wear time to estimate daily activity intensity averages (minutes) for each participant.

Calculation of Kidney Function

We estimated kidney function (based on eGFR) using the Modification of Diet and Renal Disease (MDRD) equation.[16,17] Kidney function was calculated for each participant using the National Kidney Foundation online GFR calculator.[18] Following eGFR calculation, we categorized participants by stage of CKD (stages III−V) per the National Kidney Foundation, Kidney Disease Outcomes Quality Initiative (KDOQI).[6]

Statistical Analyses

Participants' demographic data was summarized using *t* tests and χ^2 tests as appropriate. Accelerometry variables were analyzed as continuous variables. One-way analysis of variance was used to examine