Title: Assessment of physical activity by accelerometer and IPAQ-short version in patients with chronic kidney disease undergoing hemodialysis

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Abstract

Aim: To compare the short version of IPAQ and accelerometer measurement of physical activity (PA) in patients undergoing hemodialysis.

Methods: Sample consisted of 40 patients (19 men) aged 45 ± 16 years. Patients reported their PA using the IPAQ during a face-to-face interview, and wore an Actigraph GT3-X accelerometer for one week to obtain minutes per day of light PA, moderate to vigorous PA (MVPA) and total PA, and raw counts per day (vector magnitude).

Results: All PA-related variables were significantly correlated between instruments (r=0.34 to 0.47) when analyzed as a group. However, when analyzed separately by gender, the relationships were present for females only (r=0.46 to 0.62). IPAQ significantly underestimated light PA (IPAQ: 180.0 min/day vs. accelerometer: 251.1 min/day, p=0.019) but no differences were found between methods for MVPA and total PA.

Conclusion: Modest correlations were found between self-reported PA time by IPAQ (short version) and accelerometer, but only for females. However, the IPAQ may underestimate light PA, which is the main form of PA in this population.

Keywords: IPAQ; questionnaire; accelerometer; physical activity; end stage renal disease, chronic kidney disease; dialysis

Introduction

Despite advances in dialysis treatment, such procedures do not guarantee the preservation of quality of life in patients with chronic renal disease. The attention to ensure quality of care for these patients can reduce the risk of hospitalization and death [1]. Several studies have demonstrated the importance and benefits of physical activity (PA) and exercise in patients on hemodialysis, such as increasing functional capacity, strength and quality of life [2–5]. Monitoring and surveying habitual PA is of paramount importance in epidemiology studies among patients undergoing hemodialysis [6]. Consequently, there is a strong rationale for establishing the validity of methods to measure PA that can be used in large cohort studies and enable comparisons across the globe.

As a field method, questionnaires are simple and cheap instruments to assess PA and their validation is important among specific populations. Over the last decade the International Physical Activity Questionnaire (IPAQ) has received special attention in the scientific literature. The IPAQ was created to fulfill the necessity to standardize the assessment of PA in different populations and cultures around the world and its reliability and validity have been reported [7]. Therefore, the IPAQ has been considered as an acceptable tool that can be used not only in regional but also in national PA-monitoring studies across diverse populations.

In spite of the benefits that PA and exercise have in patients with chronic renal disease undergoing hemodialysis, no study has examined the validity of the IPAQ in this population group. This is important, as questionnaires designed for the healthy population may not extrapolate to disease populations, such as patients with chronic renal failure [8]. The objective of this study, therefore, was to examine whether the IPAQ (short version) provides valid measures of PA in patients with chronic kidney disease undergoing hemodialysis, when compared to PA objectively assessed using accelerometery.

Methodology

Participants and study design

Patients from two centres of hemodialysis in the countryside of São Paulo State (Brazil) were invited to participate in this cross-sectional study. These patients were randomly selected from standard patient treatment groups, which were classified according to the day of the week (Monday, Wednesday and Friday, or Tuesday, Thursday and Saturday) and time of the day (morning, afternoon and night). Each of the six groups had ~ 25 patients, and for the present study, two groups were randomly selected. The inclusion criteria to participate in this study were: 1) to be older than 18 years of age and 2) to have undertaken hemodialysis for more than 3 months. Patients in a wheelchair, presenting disability, or those who had amputation and malformation of the lower limbs, causing impaired walking, were excluded from the study.

Fifty-one patients (54 ± 16 years old) fulfilled the inclusion criteria. However, after data collection, 11 patients (6 males aged 61 ± 9 years and 5 females aged 41 ± 9 years) were excluded from study, as they did not have valid PA data. Finally, 40 patients (19 male) with a mean age of 54 ± 16 years were included in this study. Clinical data of the patients, such as values of hemodialysis adequacy (Kt/V), creatinine and hemoglobin, and body mass index (BMI) were collected from the hospital.

The procedures used in this study meet the criteria of the Ethics in Human Research according to resolution number 196/96 of the Brazilian Health Ministry and the study was approved by the Ethical Research Committee of Universidade Estadual Paulista - UNESP (process number: 1048/46/01/10). All patients provided written consent to partake in the study.

Initially, all patients were given detailed instructions about wearing an accelerometer for a consecutive 8-day period then in a second meeting the IPAQ (short version) questionnaire was applied through face-to-face interview by a trained researcher to assess the patients PA. All procedures were applied during a hemodialysis day.

IPAQ (short version)

The IPAQ was applied in its reduced version to assess a typical week of PA. The International Group proposed the IPAQ for Consensus on Measures of Physical Activity, under the seal of the World Health Organization, with representatives from 12 countries, including Brazil. It is an instrument developed in order to estimate the level of PA in populations across different countries and sociocultural contexts [7].

The IPAQ is available in different languages, including Portuguese, meaning no translation was required for this study. The short version is composed of eight questions, which are used to estimate the time spent per week performing different PA intensities. The short form records the activity of four intensity levels: 1) vigorous-intensity activity such as aerobics, 2) moderate-intensity activity such as leisure cycling, 3) walking or light activity, and 4) sitting. For all intensity levels the patients were asked how many days per week and minutes per day they performed the activity for 10 or more minutes continually. To quantify the PA levels the product of the duration (minutes/day) and frequency (days/week) were used to estimate light PA, moderate and vigorous PA (MVPA), and total PA. Sedentary time was not considered for the analysis.

Accelerometry

Actigraph GT3X (Actigraph LLC, Pensacola, FL) accelerometers were used to assess PA at different intensities. Accelerometers were placed on the patients' waist by using an elastic band. The patients wore the accelerometer for eight days (seven were full days). The patients were instructed to wear the accelerometer during all time awake and only to remove it for water-based activities, such as personal hygiene or swimming. The epoch (time sampling interval) was set at 60 s, as in this population, PA is typically of a low intensity and long duration [9], which is standard for monitoring free-living adults [10]. Data with periods of continuous zero values for more than 60 minutes were taken as the patient having removed the accelerometer. At least 5 days of recording with a minimum of 10 or more hours of registration per day [7] were necessary for the patient to be included in the study. Commercially available software (ActiLife5 Data Analysis Software by Actigraph) was used for the data analysis.

The PA intensities were determined as follow: time spent in light-intensity (100-1951 counts/min), time spent in moderate-vigorous intensity (≥1952 counts/min)[11]. Time spent in sedentary behavior (<100 counts/min) was not computed in our analysis. In the present study, counts per minute in the vertical vector were used according to previous cut points available in the literature, since, nowadays, there are no three vector's thresholds to distinguish sedentary time from light PA. Counts for vector magnitude per day (sum of the 3-axis) was calculated and compared with total time of questionnaire PA.

Statistical Analysis

Descriptive characteristics of the whole sample and by gender are provided. Continuous data are reported as mean and standard deviation (normally distributed variables) or median and interquartile intervals (non-normally distributed variables). Categorical data are reported as absolute values and percentages. Mean differences in descriptive characteristics were examined using a Mann-Whitney test (non-parametric data), Student t-test (parametric data) or Chi-squared test (categorical data). The Wilcoxon test showed mean differences between the measurement tools and Spearman's rank-order correlations were used to examine the strength of the relationship. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS) statistical software (version 18.0, Inc., Chicago, IL, USA), with the alpha level set at 0.05.

Results

Descriptive characteristics

The demographic and clinical status of the patients is reported in Table 1. Nineteen men and 21 women completed all data collection; the main age of patients was 54 ± 16 years (20, min; 89, max). Hypertension was the most prevalent primary disease (42.5%), followed by diabetes (17.5%) and interstitial nephrite (17.5%). 7.5% of patients had glomerular nephrite as the primary disease and 15% were indeterminate. Patient's characteristics did not differ by gender, except for creatinine and Kt/V.

Physical activity

The total mean counts per day were 335,126 ± 170,441 (men: 301,843 ± 153,979 and women: 365,238 ± 182,496; p=0.245). Table 2 shows the Spearman's rank order correlations of the PA measures using accelerometer and IPAQ. There were modest, but significant positive correlation for all intensities of PA, total PA and total counts/minutes using accelerometry and IPAQ. When analyzed separately by gender, no relationships were found between the accelerometry measured PA and IPAQ PA among men, but positive relationships were found for women (r=0.48-0.62).

Table 3 shows descriptive data for PA measures using the accelerometer and IPAQ as a group and stratified by gender. For the overall group, patients reported significantly lower time spent performing light PA (p=0.019) when measured using the IPAQ compared to the accelerometer. No other mean differences in PA status between assessment methods were observed.

Discussion

To our knowledge this is the first study to examine the validity of measuring the PA status of patients undergoing hemodialysis using both the IPAQ (subjective) and accelerometry (objective) techniques. Our novel findings are: 1) for the whole group, modest positive correlations (r=0.34 to 0.47) were found for measuring PA using the two methods, although when stratified by gender this positive relationship only remained for the female patients (r=0.46 to 0.62); and 2) for the whole group the IPAQ method significantly under reported the time spent performing light PA when compared to the accelerometer method. We are not aware of any other studies that have used the IPAQ to quantify the PA status of patients undergoing hemodialysis treatment. However, we can compare our data to studies conducted on other populations. Overall, correlations found in the present study are similar to those reported in the 12-Country Reliability and Validity Study of IPAQ short-version (r=0.30) [7], as well as correlations reported in a recent systematic review (r=0.39 to 0.90) [12].

An interesting finding in our study was that significant positive correlations between the IPAQ and accelerometer masured PA where only present for the female patients. In general the literature is inconsistent when examining gender differences between IPAQ and accelerometer derived PA among the healthy population. In a recent study, researchers found significant relationships for total PA in men (r=0.44) but not in women, while for moderate PA a significant correlation was observed for women (r=0.32) but not men [13]. However, others have reported no differences between males and females when comparing both instruments in a sample of Swedish adults [14].

In the current study the IPAQ was found to significantly underestimate light PA, and although data showed higher minutes per day of MVPA for the superior quartiles (75^{th}) (often by 270% the MVPA measured by accelerometer), this did not reach significance. In contrast, previous IPAQ studies have typically reported an overestimation of PA when compared to PA measured using an accelerometer [13–15], mostly due to an overestimation for MVPA. For example, researchers have shown an overestimation in the MVPA time reported by the IPAQ short form in Swedish adults (aged 20 to 69 years) (mean difference: -25.9 min/day total PA; 95% limits of agreement: -172 to 120 min/day)[14]. In a study with women diagnosed with breast cancer (average age 57 years) it has been reported that the IPAQ significantly overestimated moderate-intensity PA by 225 minutes per week (239%) and vigorous PA by 31 minutes per week (342%) [15]. In contrast to our data, the same study found that the total PA for the IPAQ was approximately three to four times greater than PA determined using accelerometers. Unfortunately, these studies did not present data for light PA separately.

Among the possibilities for differences between instruments in our sample include a lack of comprehension due to cognitive capacity and memory, as reported in previous studies [8]. It is possible that the underreporting of time spent in light PA was related to a misreporting of activities in the home environment as our sample consisted of a large proportion (70%) of housewives and unemployed people. Unlike leisure-time PA, PA performed at work or in the domestic environment has considerable variation both within and between days with regard to the intensity, duration and rest periods associated with the PA. This may cause inconsistencies when self-reporting PA [8]. Yet, studies have shown that hemodialysis patients have low physical capacity compared to age-matched healthy counterparts [16,17]. In addition to the time spent during hemodialysis (4 to 5 hours of sedentary behavior) plus time to travel to the dialysis unit (three times per week), could have resulted in patients overestimating time spent sedentary. For this reason, it is possible that a self-report instrument that is modified for groups that undertake predominantly light intensity PA (i.e. is better able to capture light PA) would improve the reporting of PA among hemodialysis patients.

It should also be considered that the accelerometer 'cut points' used to assess PA in this study might not hold true for this population, and thus introduced error into the calculated levels of PA. Indeed, the cut-points used in the current study were developed in a laboratory setting with younger adults during treadmill walking and running [11], and it has been suggested that the method of accelerometer calibration can underestimate time spent performing lifestyle activities such as housekeeping [18]. It could also be assumed that the impact of renal disease on resting metabolic rate and the energy cost of exercise [19], would alter the relationship between metabolic rate and accelerometer counts in this patient group. Thus, patients in this population may be required to meet a lower 'cut point' to reach moderate or vigorous PA. Accelerometers also have a poor ability to assess movements such as cycling, walking uphill, upper body activities and carrying loads. In addition to these limitations, despites its homogeneity, our study included a small sample of patients.

In the last 15 years, the number of studies aimed at investigating the relationship between PA and chronic kidney disease has increased. However, some of them have assessed PA using a non-validated questionnaire in this population [20–23]. To date, no study has sought to determine the validity of using the IPAQ short version in the dialysis population, despite its use in previous studies [24–26]. From a statistical point of view, the bias observed for PA provided by non-validated questionnaires is likely to affect the relationship observed between PA and its determinants. Therefore, important determinants of PA may have gone undetected in previous studies, and conversely, established determinates of PA require confirmation using validated techniques. Given the relationship between quality of life, mortality and levels of PA, it is important not only to provide appropriate surveillance, but also to facilitate comparisons with other populations.

Moreover, the identification of PA correlates in the dialysis population is of importance for the development of more effective PA and public health programs with this population, given the potential health benefits that PA can promote in this patient group [27–29].

In conclusion, this study found modest correlations between PA assessed by IPAQ (short-form) and accelerometer among patients undergoing hemodialysis, suggesting appropriate validity. However, when analysed by gender, positive relationships were only found for females, suggesting the IPAQ is only valid in this group. In addition, the IPAQ underestimated the time spent performing light PA which is a concern given that these patients are likely to spend the majority of their time performing this type of PA. Although our findings warrant further exploration by others they suggest caution in the use of IPAQ among hemodialysis patients, especially males and those who undertake high levels of light intensity PA.

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Table 1. Characteristics of study subjects stratified by gender

Characteristics	Overall (n= 40)	Men (n=19)	Women (n=21)	P value
Age, *years*	54.0±16.0	54.2±17.8	52.9±4.5	0.793
Black race	18(45)	6(33)	12(66.7)	0.192
≤8 year education	27(67.5)	12(44.4)	15(55.6)	0.826
Work/house wife	21(52.5)	8(38.1)	13(61.9)	0.350
Diabetes	7(17.5)	4(57.1)	3(42.9)	0.689
Dialysis, *months*	30(12.3;58.5)	25.0(13.0;82.0)	40.0(12.0;58.0)	0.694
BMI, kg/m^2	23(21.0;25.0)	23.7(22.0;27.0)	22.9(20.3;24.0)	0.071
Kt/V	1.17(1.04;1.39)	1.06(0.88;1.14)	1.33(1.23;1.65)	0.002
Creatinine, *mg/dL*	4.1±0.3	10.5±3.6	8.4±2.3	0.038
Hemoglobin, *g/dL*	12.0±14	11,9±1.5	11,4±1.4	0.256

Note. 8 years or less of education, ≤8 year at school; has an occupational profession, Work.

Table 2. Relationship between accelerometer and IPAQ derived PA status

	Overall (N=40)	Men (N=19)	Women (N=21)
Light PA	0.340*	0.263	0.463*
MVPA	0.389*	0.270	0.518*
Total PA	0.416*	0.322	0.551*
Counts vs. Minutes	0.471*	0.290	0.616*

Note. Light Physical Activity, Light PA; Moderate Vigorous Physical Activity, MVPA; Total Physical Activity, Total PA; Total accelerometer counts, Counts; Total minutes of physical activity by IPAQ, Minutes. * Statistically significant ($P<0.05$).

Table 3. Physical activity for both instruments overall, stratified by gender and age

Measure (minutes/day)	Overall (N=40)	Men N=19	Women N=21
IPAQ			
Light PA	180.0(102.0-292.5)*	128.6(85.7-330.0)	180.0(120.0-285.0)
MVPA	4.0(0.0-42.9)	8.6(0.0-42.9)	0.0(0.0-60.0)
Total PA	180.0(128.6-360)	162.9(98.6-360.0)	240.0(137.1-368.6)
Accelerometer			
Light PA	251.1(193.4-312.4)*	273.6(189.4-344.7)	231.7(198.0-284.5)
MVPA	5.7(1.3-15.9)	3.9(0.9-15.4)	6.2(1.5-22.5)
Total PA	260.3(195.7-260.3)	282.5(193.4-353.4)	260.2(202.2-309.5)

Note: International Physical Activity Questionnaire, IPAQ; Moderate-Vigorous physical activity, MVPA; Total accelerometer counts, Total Counts. *Statistical difference between instruments.