ORIGINAL RESEARCH

Characterization of Physical Activity and Sitting Time Among Patients on Hemodialysis Using a New Physical Activity Instrument

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Objectives: Physical activity questionnaires usually focus on moderate to vigorous activities and may not accurately capture physical activity or variation in levels of activity among extremely inactive groups like dialysis patients.

Design: Cross-sectional study.

Setting: Three dialysis facilities in the San Francisco Bay Area.

Subjects: Sixty-eight prevalent hemodialysis patients.

Intervention: We administered a new physical activity questionnaire designed to capture activity in the lower end of the range, the Low Physical Activity Questionnaire (LoPAQ).

Main Outcome Measure: Outcome measures were correlation with a validated physical activity questionnaire, the Minnesota Leisure Time Activity (LTA) questionnaire and with self-reported physical function (physical function score of the SF-36) and physical performance (gait speed, chair stand, balance, and short physical performance battery). We also determined whether patients who were frail or reported limitations in activities of daily living were less active on the LoPAQ.

Results: Sixty-eight participants (mean age 59 ± 14 years, 59% men) completed the study. Patients were inactive according to the LoPAQ, with a median (interquartile range) of 517 (204-1190) kcal/week of physical activity. Although activity from the LTA was lower than on the LoPAQ (411 [61-902] kcal/week), the difference was not statistically significant ($P = .20$), and results from the 2 instruments were strongly correlated (rho = 0.62, $P < .001$). In addition, higher physical activity measured by the LoPAQ was correlated with better self-reported functioning (rho = 0.64, $P < .001$), better performance on gait speed (rho = 0.32, $P = .02$), balance (rho = 0.45, $P < .001$), and chair rising (rho = −0.32, $P = .03$) tests and with higher short physical performance battery total score (rho = 0.51, $P < .001$). Frail patients and patients with activities of daily living limitations were less active than those who were not frail or limited.

Conclusions: The LoPAQ performed similarly to the Minnesota LTA questionnaire in our cohort despite being shorter and easier to administer.

Introduction

THERE ARE MYRIAD instruments available to quantify physical activity. Choice of instrument depends on the activity level of the population under study and the outcomes of interest, among other considerations. A number of different questionnaires of physical activity have been used to assess patients treated with hemodialysis, and this group has been found to be extremely inactive. Furthermore, level of physical activity has been associated with survival among patients on dialysis.[1,2] However, previous studies have relied on questionnaires that were not specifically designed for this population.[3-6] Many of these instruments focus on moderate to vigorous activities because these are the levels that have been most consistently related to health benefits in healthy populations. As a result of the focus on higher intensity activity, these instruments may not accurately capture physical activity or variation in levels of activity among extremely inactive groups.[7] The Human Activity Profile (HAP)[3,4] has been relatively widely used in the dialysis population because it spans a wider range of activities than most questionnaires and does assess activity at the lower end of the spectrum. However, although HAP scores categorize participants according to general activity level, they do not quantify specific amounts or intensity of physical activity performed and thus do not translate well into benchmarks that can be used by clinicians and patients, such as calories of energy expenditure or minutes of moderate activity. In addition, because physical activity is not assessed over a specific time interval by the HAP, scores may not be sensitive to change with intervention. Finally, there is increasing recognition that, especially among sedentary populations, time spent sitting may have adverse effects on outcomes independent of the level of participation in activity.[8-11]

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To address these limitations, we developed the Low Physical Activity Questionnaire (LoPAQ), which focuses on very low levels of physical activity, specifically walking, but also quantifies kilocalories of total leisure-time physical activity and time spent sitting. We hypothesized that physical activity measured using the LoPAQ would correlate with activity measured using a standard instrument used commonly among community-dwelling elderly populations and with physical performance and patients' self-reported physical function. We also hypothesized that sitting time would be inversely correlated with functioning.

Methods

Study Design and Participants

This was a cross-sectional study performed on a subset of participants in the United States Renal Data System ACTIVE/ADIPOSE (A Cohort To Investigate the Value of Exercise/Analyses Designed to Investigate the Paradox of Obesity in ESRD).[12] ACTIVE/ADIPOSE enrolled 771 prevalent adult hemodialysis patients from 14 dialysis facilities in the San Francisco Bay Area and the Atlanta metropolitan area from June 2009 and August 2011. Patients were eligible to participate if they were adults who had been receiving maintenance hemodialysis for at least 3 months, were able to provide informed consent, and spoke English or Spanish. The study was approved by the Institutional Review Boards at the University of California, San Francisco and Emory University, and all participants provided written informed consent.

Study coordinators interviewed participants before or during a dialysis session, abstracted recent clinical and laboratory data from medical records, and measured physical performance on the same day. For this ancillary study, all 68 English-speaking participants previously enrolled in ACTIVE/ADIPOSE who were scheduled for a study visit in the San Francisco area between February and June, 2013 were asked to complete the LoPAQ. All patients agreed to participate, completed the questionnaire, and were included in the analyses.

Low Physical Activity Questionnaire

The LoPAQ was developed with dialysis patients in mind based on the investigators' prior experience with measurement of physical activity in this population (see Appendix).[7,13,14] Our goals were to create an instrument that would be short, would focus on physical activity at the low end of the physical activity range, and would produce quantitative results that could be used to compare patients with each other and to determine whether participants meet guideline-recommended levels of physical activity.[15,16] For this study, coordinators administered the questionnaire and recorded participants' responses. We used a 1-week assessment period to minimize the burden of recollection and maximize the potential sensitivity to change in response to changes in clinical status or interventions to increase activity. In an effort to produce quantitative data that can be used by patients, clinicians, and researchers to assess risk and to encourage physical activity, we used measures that are readily understandable and can be directly compared with available metrics, including minutes of walking per week and kilocalories expended in light, moderate, vigorous, and total physical activity. We asked participants about walking around the neighborhood, for transportation, and for fitness or pleasure. In addition, we asked about the average time spent in sitting activities over 1 week.

Other Measures

The Minnesota Leisure Time Activities (LTA) questionnaire[17] was used as a standard reference. The LTA has been used in numerous epidemiologic studies, including the Cardiovascular Health Study.[18,19] This instrument asks participants about participation in 18 different activities over the previous 2 weeks. Based on the responses, the total number of calories (kcal) expended in LTA per week is estimated.

Self-reported physical function was assessed using the Physical Function scale of the SF-36,[20] which asks participants whether they are limited in performing 10 activities and is scored from 0 to 100, with higher scores indicating better function.

Physical performance was assessed using the Short Physical Performance Battery (SPPB),[21] and its individual components, which include gait speed, a timed sit-to-stand test, and balance tests. Performance tests were conducted immediately before a midweek dialysis session. Gait speed was measured twice over a 15-foot course, and the fastest time recorded. Patients were timed while rising from a standard chair 5 times as fast as possible without the use of their arms. Finally, patients were timed while maintaining a standing position with feet side by side, a semitandem position, and a tandem position for up to 10 seconds each. A total SPPB score was calculated based on the results of the performance tests, with each component scored from 0 (unable to perform) to 4 (best performance), with a total score ranging from 0 to 12.[21] We measured grip strength in the nonfistula arm using a Jamar hand-held dynamometer (Sammons Preston Rolyan, Bolingbrook, IL) during 3 trials of maximal effort. The highest force generated was used as the outcome measure.

We assessed frailty according to Fried's criteria, which was originally developed among community-dwelling elderly[18] and more recently applied to patients on hemodialysis.[22,23] Patients were considered frail if they met 3 or more of the following 5 criteria: unintentional weight loss of 10 pounds or more in the prior year by self-report; exhaustion based on responses to 2 questions about energy; low physical activity based on the Minnesota LTA ($<$383 kcal/week for men or $<$270 kcal/week for women); slow gait speed (based on gender- and height-stratified cutoffs); and weak grip strength (based on

gender- and body mass index–stratified cutoffs). Patients were asked whether they were independent in the following activities of daily living (ADL): bathing, dressing, getting in and out of a chair, and walking around their home or apartment.[12] Those reporting dependency in 1 or more were considered to have an ADL limitation.

Statistical Analyses

Patient characteristics and physical activity results were summarized using mean and standard deviation for normally distributed variables, median and interquartile range (IQR) for nonnormally distributed variables, and percentages for categorical variables. Spearman correlations were used to determine whether the LoPAQ results correlate with kilocalories of energy expenditure from the Minnesota LTA and with other outcomes expected to correlate with physical activity, including self-reported function (SF-36, ADLs), physical performance (gait speed, sit-to-stand test, balance, and the SPPB total score), and frailty. We also assessed associations of sitting time with these outcomes using Spearman correlation. Analyses were performed in Stata 13.1 (StataCorp LP, College Station, TX), and P values less than .05 were considered statistically significant.

Results

Sixty-eight participants completed the LoPAQ. Mean age was 59 ± 14 years, 59% were men, and 49% had diabetes mellitus (Table 1). Twenty-three participants (34%) met the criteria for frailty, and 16 reported at least 1 ADL disability.

Overall kilocalories per week of physical activity reported on the LoPAQ were 517 (IQR, 204-1190), equivalent to approximately 21 minutes/day of moderate activity. A median of 57% (IQR, 24%-82%) of reported activity was in the form of walking, including around the neighborhood, for transportation, and for fitness or pleasure, with a median of 315 (0, 735) kcal/week (equivalent to 90 [0, 210] minutes). Participants reported a median of 5 (3-8) hours of sitting per day.

Participants reported 411 (61-902) kcal of energy expenditure per week on the Minnesota LTA. Activity reported on the LoPAQ correlated with that reported on the Minnesota LTA (rho = 0.62, $P < .001$). The median difference between the 2 questionnaires was 20 kcal (IQR, 189-385, $P = .20$). Energy expenditure in walking between the 2 instruments was highly correlated (rho = 0.58, $P < .001$), but participants reported significantly more walking on the LoPAQ ($P = .03$ by Wilcoxon signed rank test). Hours of sitting activities on the LoPAQ correlated negatively with energy expenditure from the Minnesota LTA (rho = −0.29, $P = .02$).

Higher physical activity measured by the LoPAQ was correlated with better self-reported functioning, better performance on each component of the SPPB and with higher SPPB total score (Table 2). Associations between physical activity and physical function and performance were similar whether activity was measured using the LoPAQ or the Minnesota LTA. In addition, longer sitting time was correlated with worse self-reported function, sit-to-stand time, and SPPB total score.

Table 1. Patient Characteristics

Characteristic	$N = 68$
Age, y	59 ± 14
Men, *n* (%)	40 (59)
Race, *n* (%)	
Black	22 (32)
White	13 (19)
Asian/Pacific Islander	29 (43)
Missing/other/multiracial	4 (6)
BMI, kg/m^2	27.8 (6.4)
Hemoglobin, g/dL	10.1 (1.5)
Dialysis vintage, y	3.7 (1.6-6.3)
Comorbidity, *n* (%)	
Diabetes	32 (49)
Hypertension	55 (85)
CHF	13 (20)
CAD	5 (8)
Physical activity, Kcal/wk	
LoPAQ	517 (204-1,190)
Minnesota LTA	411 (61-902)
Physical Function and performance	
Self-reported*	40 (20-77.5)
Gait speed, m/s	0.93 (0.68-1.07)
Sit-to-stand, s†	12.5 (9.4-15.3)
Hand grip, kg	20.4 (15.0-32.0)
Composites	
SPPB, score	9 (6-12)
Frail, %	23 (34)
ADL limitation, %	16 (24)

BMI, body mass index; CAD, coronary artery disease; CHF, congestive heart failure; LoPAQ, Low Physical Activity Questionnaire; LTA, leisure-time activity; SPPB, short physical performance battery.

Continuous variables are mean (standard deviation) or median (interquartile range).

*Physical Function score of the SF-36.

†Among the 46 participants able to perform the test.

Frail patients were less active on the LoPAQ than those who did not meet frailty criteria (Table 3). However, since physical activity (using the Minnesota LTA) was included in the frailty criteria, we also assessed whether patients who reported 1 or more disabilities in ADLs were less active and found an even larger difference between patients with and without ADL limitation. Frail patients also reported more sedentary time than those who were not frail (6.5 vs. 5 hours, $P = .04$), but there was no statistically significant difference in sedentary time between those with and without ADL limitation.

Discussion

We found that energy expended in leisure-time physical activity obtained from the LoPAQ correlated well with that from the Minnesota LTA questionnaire. Furthermore, energy expenditure from the LoPAQ was associated with

Table 2. Correlations Between Physical Activity and Related Parameters

	Minnesota LTPA kcal Activity/wk		LoPAQ kcal Activity/wk		LoPAQ Sitting Time (h)	
Variable	Rho	*P* value	Rho	*P* value	Rho	*P* value
PF scale SF-36	0.66	<.001	0.64	<.001	−0.30	.01
Gait speed, m/s	0.35	.007	0.31	.02	−0.10	.45
Sit-to-stand, s	−0.35	.02	−0.32	.03	0.34	.02
Balance, s	0.42	<.001	0.45	.001	−0.20	.11
SPPB	0.49	<.001	0.51	<.001	−0.20	.03

LoPAQ, Low Physical Activity Questionnaire; LTA, leisure-time activity; PF, Physical Function; SF-36, Medical Outcomes Study Short Form 36-Item questionnaire; SPPB, short physical performance battery.

patients' self-reported physical functioning and with several tests of physical performance. Sedentary behavior was associated with worse self-reported function and worse performance on the SPPB.

Overall, these results demonstrate that the LoPAQ has reasonable construct validity. Not only did our instrument correlate with another, validated instrument, but it also correlated with other constructs expected to be associated with physical activity, including self-reported functioning. Although self-reported physical functioning is a different concept than physical activity, asking participants about the level of difficulty they experience in completing tasks rather than asking the frequency with which they actual do them, self-reported function and physical activity are usually interrelated, particularly in low-active populations. Similarly, although gait speed and other tests of physical performance have "ceiling effects" that keep them from being closely tied to physical activity in healthy populations, in populations with more limited performance, such as our dialysis population, those who are more active generally have better performance.

Although the LoPAQ performed similarly to the Minnesota LTA questionnaire in our study cohort, it may offer some advantages. First, the LoPAQ is shorter than the Minnesota LTA and other similar instruments, taking approximately 10 minutes to administer, including instructions to participants, compared with the 20 minutes required for the Minnesota LTA.[17] Second, the LoPAQ also collects information about the amount of time spent in sedentary, sitting activities, which recent research suggests may be independently associated with adverse outcomes[8-11] and which could be targeted separately in interventions to increase physical activity (or decrease sedentariness). Finally, the focus on walking may be an advantage. Several other instruments that measure physical activity among the elderly or low-active populations and have been used in the dialysis population, including the Minnesota LTA and the Physical Activity Scale for the Elderly,[5,17] contain questions about activities that are often not performed by low-income individuals or those living in an urban setting, such as ballroom dancing, gardening, tennis, and racquetball. Some participants have commented that such questions do not seem to be relevant to their lifestyles. The focus on walking could also render the LoPAQ more responsive to changes in routine physical activity, particularly in the setting of interventions to increase walking.

Questionnaires typically measure leisure-time physical activity—that is, activity that occurs above and beyond that required to perform ADL and occupational activity—although some questionnaires do include occupational physical activity. Reasons to focus on leisure-time activity in this manner include ease of assessment in large populations and the notion that leisure-time physical activity is the portion of activity that is modifiable. More objective measures of physical activity such as energy expenditure or pedometry are often considered to be more reliable because of their objective nature, but although they are expected to correlate with leisure-time activity, these measures are based on total activity, including occupational activity and activity related to ADLs. We did not compare our questionnaire to steps using pedometry, but recent studies that have collected physical activity data among patients on dialysis using pedometers or other activity monitors have generated higher estimates of kilocalories of physical activity than ours.[24-26] The higher activity levels in those studies were likely related at least in part to measurement of total activity rather than leisure-time activity. However, these studies were all from Europe, and it is possible that there are real differences in physical activity between patients from Europe and from the United States. Nevertheless, distinguishing activity in this low end of the spectrum may be important because differences in physical

Table 3. Physical activity Levels Based on Frailty or Disability Status

Frailty or Disability Status	Minnesota LTA Activity	LoPAQ Activity	Sitting
Frail	95 (0-280)	280 (20-560)	6.5 (4-10)
Not frail	735 (350-1,260)	798 (375-1,415)	5 (3-6.7)
P value	<.001	.003	.04
ADL disability	65 (0-275)	50 (0-411)	7 (3-10)
No ADL disability	590 (166-1,103)	767 (303-1,538)	5 (3-7.1)
P value	<.001	<.001	.16

ADL, activities of daily living; LoPAQ, Low Physical Activity Questionnaire; LTA, leisure-time activity.

activity even at very low levels have been shown to be associated with survival in the dialysis population.[2] Future studies are needed to directly compare physical activity by LoPAQ with pedometry in patients on dialysis.

Our study has several limitations. We enrolled a convenience sample of patients receiving hemodialysis in the San Francisco Bay Area, and the racial/ethnic distribution matches that of the Bay Area but differs somewhat from that of the US dialysis population. We did not compare the LoPAQ to a gold standard such as energy expenditure based on doubly labeled water or to objective measurements such as by pedometers or accelerometers. On the other hand, we did compare the performance of the LoPAQ to that of a standard, well-validated instrument that is commonly used in this patient population. We did not evaluate the test–retest reliability of the LoPAQ nor was this a study in which we could evaluate the extent to which it is responsive to changes in physical activity.

In summary, we found that the LoPAQ performed similarly to the Minnesota LTA questionnaire in our cohort of patients on hemodialysis despite being shorter and easier to administer. Further studies are needed to confirm the utility of the LoPAQ. In particular, it will be important to determine whether physical activity assessed by the LoPAQ correlates with objective measures of activity such as steps counts and whether it is responsive to changes in physical activity, which could include increased activity resulting from interventions or decreased activity as a result of changes in medical status.

Practical Application

Physical activity questionnaires designed for the general population or for healthy elderly may overestimate activity because they focus on moderate and vigorous activity. We designed and tested a new LoPAQ targeted to dialysis patients. The new questionnaire performed similarly to an established questionnaire, correlated with physical performance and self-reported physical function, and took half the time to administer. This instrument may be useful in the clinical setting for assessment and monitoring of participation in physical activity.

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Appendix

Low Physical Activity Questionnaire (LoPAQ)

1. Please check all of the statements that describe your walking in the last week
   ☐ I walked around the neighborhood
   I walked_____times during the week.
   I walked for approximately_____minutes per session.
   ☐ I walked for transportation (i.e., to the store, etc.)
   I walked_____times during the week.
   I walked approximately_____minutes per session.
   ☐ I walked for the purpose of improving my fitness or for pleasure (above and beyond daily necessities)
   I walked_____times during the week.
   I walked approximately_____minutes per session.
   ☐ I did not walk.
2. In the past 7 days, did you participate in other activities that would be described as "light" activities? These are activities that make your heart beat a bit faster than usual—you could talk and sing while doing them. Examples would be: light yard or gardening work, bowling, golfing, boating (motor), leisure bicycling, stretching, yoga, chair exercises or light housework such as folding laundry or washing dishes?
   ☐ no ☐ yes
   if yes, I participated in these light activities_____times during the week for an average of_____minutes per session.
3. In the past 7 days, did you participate in activities (other than walking) that would be described as "moderate" activities? These activities would make your heart beat faster than usual, and you could talk, but not sing while doing them. Examples of moderate activities would be: aerobics class, swimming (the side stroke or breast stroke), bicycling in the neighborhood, playing badminton or table tennis, softball, downhill skiing or moderate housework such as vacuuming or making beds.
   ☐ no ☐ yes
   if yes, I participated in these moderate activities_____times during the week for an average of_____minutes per session.
4. In the past 7 days, did you participate in activities (other than walking) that would be described as "vigorous" activities? These would make your heart beat lots faster, make you breathe heavily, making your talking broken up by large breaths. Examples of vigorous activities would be: jogging or running, playing tennis or racquetball, playing soccer, basketball, cross- country skiing, using stepping machines or other equipment at the gym.
   ☐ no ☐ yes
   if yes, I participated in these vigorous activities_____times during the week for an average of_____minutes per session.
5. In the past 7 days, did you do specific exercises for strengthening muscles?
   ☐ no ☐ yes
   if yes, I participated in these strengthening exercises_____times during the week.
6. In the past 7 days, did you do exercises for stretching your muscles (flexibility exercises)?
   ☐ no ☐ yes
   if yes, I participated in these stretching or flexibility exercises_____times during the week.
7. In terms of physical activity and walking, was this a typical week for you?
   ☐ no ☐ yes
8. In the past 7 days, how much time did you spend sitting, watching television, reading or in front of a computer?
   _____hours/day (average)
9. In the past 7 days, did you nap at home during the day?
   ☐ no ☐ yes
   if yes, I napped_____times.
   when you nap, how long do you nap? _____minutes
10. In the past 7 days, how many hours were you in bed at night?_____hours/night (average)

11. Do you work outside the home?	☐ no	☐ yes
if yes, does your job require you to do walking?	☐ no	☐ yes
if yes, your job require you to do physical exertion such as lifting?	☐ no	☐ yes