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Utility of the low physical activity questionnaire for hemodialysis patients with frailty: a cross-sectional study

Sachi Yamabe[1,2], Shohei Yamamoto[3*], Manae Harada[2], Yuta Suzuki[4], Keigo Imamura[5], Shun Yoshikoshi[1,5], Shiwori Osada[6] and Atsuhiko Matsunaga[1]

Abstract

Background The low physical activity questionnaire (LoPAQ), which has been developed to assess the low levels of physical activity in patients on dialysis, is so far available only in English. Moreover, no study has examined whether the LoPAQ can be used to screen for frailty in patients on hemodialysis. The purpose of this study was to translate the original LoPAQ into Japanese and evaluate its utility in screening for frailty among patients on hemodialysis.

Methods For this cross-sectional study, we enrolled patients from two hemodialysis facilities in Japan between April 2018 and June 2019. We used the LoPAQ to calculate physical activity for one week, with pedometer steps (steps/week) as the standard reference. We used Spearman's rank test and two multiple linear regression models to assess the relationship between the Japanese LoPAQ results and pedometer step counts. Finally, we examined whether the LoPAQ had the ability to screen for frailty (Fried scale ≥ 3) using area under the curves.

Results In total, 220 patients on hemodialysis completed the LoPAQ and wore a pedometer for one week. Their mean age was 67.8 ± 11.6 years, and 59.1% were men. The LoPAQ showed a total physical activity of 825.0 kilocalories/week and walking activity of 315.0 kilocalories/week. The LoPAQ total physical activity and walking activity were significantly correlated with pedometer step counts ($r = 0.37$–0.53, $P < 0.01$). Furthermore, LoPAQ total physical activity and walking activity were associated with pedometer step counts despite adjusting for covariates (β: 3.33–5.45, $P < 0.001$, β: 8.63–16.80, $P < 0.001$, respectively). In addition, the LoPAQ total physical activity and walking activity showed good values in the area under the curves to identify frailty (0.72 and 0.73, respectively).

Conclusions Physical activity assessed using the LoPAQ significantly correlated with pedometer step counts in Japanese patients on hemodialysis. Furthermore, the LoPAQ total physical activity and walking activity had a moderate screening ability for frailty. The results indicate that the LoPAQ questionnaire is useful as a physical activity assessment tool and as a screening tool for frailty in patients on hemodialysis.

Keywords Hemodialysis, Physical activity, Questionnaire, Frailty, LoPAQ

*Correspondence:
Shohei Yamamoto
shh.ymmt@gmail.com
Full list of author information is available at the end of the article

Background

The prevalence of frailty is considerably higher among outpatients on hemodialysis (30–40%) [1–3] than the community-dwelling older population (4–17%) [4, 5]. In patients on hemodialysis, frailty is strongly linked to a higher risk of mortality [6, 7]; thus, it is important to accurately identify frailty status for early prevention and treatment. Low physical activity has been suggested to be a useful marker for screening for frailty in patients on hemodialysis [8, 9].

In the literature on physical activity and patients on hemodialysis, both pedometers and questionnaires have been widely used as assessment tools [10, 11]. In particular, questionnaires have the advantage of being simple and easy to use in clinical settings and epidemiological surveillance. However, most existing questionnaires center on moderate to vigorous levels of activity; thus, they may not accurately capture lower levels of physical activity (e.g., light walking and sedentary behavior) [12, 13]. In light of the extremely low levels of physical activity displayed by patients on hemodialysis [12, 14–16], the low physical activity questionnaire (LoPAQ) was developed to assess lower levels of physical activity, such as the activities of walking around the neighborhood, walking for transportation, and sedentary time [17]. The previous study conducted among patients on dialysis in the USA reported that the LoPAQ total physical activity (kilocalories (kcal)/week) significantly correlated with pedometer step counts [18].

However, some important issues related to the LoPAQ still need to be addressed. First, the LoPAQ was developed in English; thus, its validity is restricted to patients in Western cultures [17, 18]. Although the majority (70%) of Japanese patients with end-stage renal disease are treated with hemodialysis [19] and their levels of physical activity have been reported to be very low [10], no study has examined the utility of the LoPAQ in assessing physical activity in this population. Second, the ability of the LoPAQ to screen for frailty still needs to be clarified. Given that patients on hemodialysis are typically characterized by multimorbidity and increasingly by advanced age [19], the Fried frailty criteria [5, 9] may be difficult to use on some patients on hemodialysis, because the criteria require the evaluation of the five components including weight loss, grip strength, exhaustion, gait speed, and physical activity. The ability of the LoPAQ to screen for frailty easily in this study can provide further justification for the utility of the LoPAQ in routine clinical practice.

Thus, we assessed the validity of the Japanese version of the LoPAQ in quantifying the level of physical activity among Japanese patients on hemodialysis compared with pedometer step counts. Further, we investigated the LoPAQ's ability to screen for frailty in patients on hemodialysis.

Methods

Study design and participants

For this cross-sectional study, we enrolled patients on hemodialysis from two dialysis facilities in Japan from April 2018 to June 2019. Patients were eligible to participate if they were aged ≥ 18 years and had been receiving in-center hemodialysis at least three times a week for at least 3 months.

The exclusion criteria were as follows: patients who could not move independently, such as those using a wheelchair; patients who had experienced a pathological worsening in the past 3 months; patients with severe motor and sensory paralysis or severe central nervous system infection paralysis; patients with severe visual impairment; patients who had undergone leg amputation; and patients with severe dementia who found it difficult to answer the LoPAQ. The study was performed according to the ethical principles of the Declaration of Helsinki and approved by the relevant Institutional Review Board/Ethics Committee of Kitasato University School of Allied Health Sciences. We explained the purpose of this study to all patients who met the eligible criteria. Among them, we included the patients who agreed to participate in our study. All the participants who were involved in this study had provided informed consent.

Japanese LoPAQ

We used the LoPAQ, which was developed in an American study [17]. First, the original English LoPAQ was translated into Japanese by a bilingual translator. Second, the three Japanese expert researchers who were familiar with the research field revised the academic words. The revised draft was again checked by the bilingual translator for any discrepancies that existed between the original version and the proofread draft, and any discrepancies and inconsistencies were adjusted until all ambiguities were rectified. The final Japanese version was agreed upon by both expert researchers and a bilingual translator. After that, we obtained approval for the use of the translated questionnaire from the original creator (Dr. Kirsten L. Johansen [17]). The Japanese LoPAQ can be found in Additional file 1.

The LoPAQ can investigate walking per week, and kcal expended through light, moderate, vigorous, and other physical activity per week. Walking includes that which is undertaken around the neighborhood, for transportation, and for fitness or pleasure. Energy was calculated by the activity intensity and the number of activities; the intensity of each activity was defined as 3.5 kcal/minute for walking, 2.0 kcal/min for light activities, 4.0 kcal/min for moderate activities, and 6.0 kcal/min for vigorous activities. Moreover, we enquired about the minutes spent on sedentary activities over a 1-week period. We calculated each physical activity on the LoPAQ using the following formula:

Physical activity (kcal/week) = intensity of each activity (kcal/min) × minutes × time (time/week).

After that, we added the calories for each physical activity to calculate the total calories for the 1-week period. Furthermore, the calories for each physical activity were calculated according to the explanation of the original creator, Dr. Kirsten L. Johansen [17].

Physical activity measured by an accelerometer

Physical activity was measured using a pedometer with an accelerometer (Lifecorder; SUZUKEN Co., Ltd., Nagoya, Japan) as the reference. The participants were instructed to wear the pedometer with an accelerometer around their belt or as a waistband continuously during the time they were awake, including weekends, except when bathing or undergoing dialysis. We also instructed the participants to wear the pedometer with an accelerometer for 10 days to 2 weeks and go about their usual activities. We analyzed the data based on 1 week of data from 2 weeks of data. These 1-week data were from the same week in which we assessed the participants' physical activity using the LoPAQ. Additionally, to rule out any instances of missing data for reasons such as the pedometer getting wet/misplaced or the patient forgetting to wear the pedometer with the accelerometer, the accelerometer data were inspected before the analysis. The missing data thus identified were supplemented by the data from the other week. For example, when data for the hemodialysis session on Wednesday in 1 week were missing, we used data from the Wednesday hemodialysis session from the other week.

Participant characteristics

We obtained data on age, sex, primary kidney disease, dialysis vintage, body mass index (BMI), pre-dialysis serum creatinine levels, serum albumin levels, serum hemoglobin levels, and comorbidity index score from patient clinic charts before assessing physical activity for 1 week. Comorbid conditions were classified as atherosclerotic heart disease, congestive heart failure, cerebrovascular accident/transient ischemic attack, peripheral vascular disease, dysrhythmia, other cardiac diseases, chronic obstructive pulmonary disease, gastrointestinal bleeding, liver disease, cancer, and diabetes [20].

The following formula, which includes serum albumin levels and body weight, was used to calculate the geriatric nutritional risk index (GNRI) [21]:

GNRI = [1.489 × serum albumin (g/L)] + [41.7 × body weight (kg)/[(height)^2 (m^2) × 22].

Based on previous studies, we calculated the ideal body weight using the following formula: (height)^2 (m^2) × 22 [22]. Ratios of body weight and ideal body weight that exceed 1 were calculated as 1 [22].

Physical performance measurement

Physical performance was assessed using the short physical performance battery (SPPB) [23]. The SPPB consists of gait speed, sit-to-stand test, and balance tests. Gait speed was measured twice over a 4-m course, and the fastest time in the two attempts was recorded. The sit-to-stand test measured the time it took to stand up five times from a standard chair as quickly as possible with the patient's arms crossed in front of their chest. The balance test was timed while maintaining a standing position with the feet side by side, in semi-tandem and tandem positions for up to 10 s each. Based on the results of the performance tests, the total SPPB score (ranging from 0 to 12) was calculated with each component assigned a score from 0 (unable to perform) to 4 (best performance).

We screened for physical frailty using the Fried frailty criteria [9]. Patients were considered frail if they met three or more of the following five criteria: unintentional weight loss of at least 5%, low grip strength, exhaustion, slow gait speed, and low physical activity. We assessed unintentional weight loss of 5% or more from the previous year's patient clinic charts before assessing physical activity for 1 week. Exhaustion was assessed using the Center for Epidemiologic Studies Depression scale [24]. Low physical activity was defined as $<$ 383 kcal/week for men and $<$ 270 kcal/week for women based on the results in kcal obtained from the pedometer with an accelerator.

Statistical analysis

The characteristics of patients with frailty and non-frailty were compared using the unpaired t-test or Wilcoxon rank sum test, and the chi-square test was used for categorical variables.

We used Spearman's rank correlation coefficient to assess the relationship between the LoPAQ results and pedometer step counts. We used the following r values to determine the results: 0.20 = small; 0.50 = moderate; 0.80 = strong correlation [25]. In addition, two multiple linear regression models were used to identify the relationship between LoPAQ results and pedometer step counts. Model 1 was adjusted for age, sex, and BMI; model 2 was adjusted for age, sex, BMI, GNRI, and comorbidity index.

Finally, receiver operating characteristic curves analysis were performed for the logistic analysis and to examine whether the four models (LoPAQ total physical activity kcal, LoPAQ walking activity kcal, LoPAQ sedentary time, and pedometer) had the ability to screen for frailty by using area under the curves (AUC). The AUC values ranged between 0.5 and 1.0. An AUC value of 1.0 indicates a perfect test while a value of 0.5 suggests a useless/unusable test. Based on these criteria, the interpretation of intermediate AUC values is as follows: low ($0.5 < AUC \leq 0.7$), moderate ($0.7 < AUC \leq 0.9$), or high ($0.9 < AUC \leq 1.0$) accuracy [26]. All analyses were performed using JMP 14 and 17 (SAS Institute Inc., Cary, NC, USA).

Results

Baseline patient characteristics

Among the 476 patients receiving hemodialysis evaluated for eligibility, we excluded six with severe cardiovascular disease, seven with severe dementia, 14 hospitalized within 3 months prior to the study, one with an amputated leg, and nine for other reasons. Additionally, 42 patients who did not agree to participate and 36 patients who died or changed clinics were excluded. Thus, 361 patients could be assessed, and the total number who completed the LoPAQ assessment was 360. In contrast, the number of patients who completed the pedometer assessment was 260; 100 patients had only LoPAQ data, and one patient had no data available for either. Altogether, both LoPAQ and pedometer data were gathered for 260 patients. Of these 260 patients, those for whom data for frailty were missing and those who needed assistance in moving were excluded. Subsequently, 220 patients were included in the final analysis.

The characteristics of the 220 patients on hemodialysis are shown in Table 1. Overall, 220 patients completed the LoPAQ, with a mean age of 67.8 ± 11.6 years, and 59.1% were men. The LoPAQ results reported a total

Table 1 Patient characteristics (overall, frailty, and non-frailty)

	Overall *n* = 220	Frailty (≥ 3 points) *n* = 67	Non-frailty (< 3 points) *n* = 153	*P* value
Characteristics				
Age, years	67.8 ± 11.6	74.7 ± 9.7	64.8 ± 11.1	< 0.001
Men, *n* (%)	130.0 (59.1)	48.0 (71.6)	82.0 (53.6)	0.012
Primary kidney disease, *n* (%)				0.046
Hypertension	20.0 (9.1)	3.0 (4.5)	17.0 (11.1)	
Glomerulonephritis	67.0 (30.5)	16.0 (23.9)	51.0 (33.3)	
Diabetes mellitus	74.0 (33.6)	23.0 (34.3)	51.0 (33.3)	
Others	27.0 (12.3)	14.0 (20.9)	13.0 (8.5)	
Unknown	32.0 (14.5)	11.0 (16.4)	21.0 (13.7)	
Dialysis vintage, years	10.0 ± 8.4	10.3 ± 8.1	9.9 ± 8.6	0.489
BMI, kg/m^2	21.8 ± 4.1	20.4 ± 3.1	22.4 ± 4.4	0.002
GNRI	94.9 ± 6.3	91.9 ± 6.3	96.2 ± 5.8	< 0.001
Pre-dialysis serum creatinine, mg/dL	10.6 ± 2.4	9.5 ± 1.8	11.1 ± 2.5	< 0.001
Serum Albumin, g/dL	3.8 ± 0.3	3.7 ± 0.3	3.8 ± 0.3	< 0.001
Hemoglobin, g/dL	10.9 ± 0.9	10.9 ± 0.9	10.9 ± 0.9	0.588
Comorbidity index, score	6.2 ± 3.3	8.0 ± 3.3	5.4 ± 3.0	< 0.001
Physical activity				
LoPAQ total physical activity, kcal/week	825.0 (369.4–1848.8)	437.5 (105.0–1082.5)	1155.0 (500.0–2240.0)	< 0.001
LoPAQ walking activity, kcal/week	315.0 (105.0–735.0)	140.0 (0–323.8)	420.0 (166.3–980.0)	< 0.001
LoPAQ sedentary time, hours/week	5.0 (3.0–6.0)	5.0 (4.0–7.0)	4.0 (3.0–6.0)	0.024
Pedometer, steps/week	23090.5 (10990.5–38275.5)	9024.0 (4554.0–13260.0)	30563.0 (19639.5–45795.0)	< 0.001
Physical performance				
Handgrip strength, kg	24.3 ± 7.9	20.0 ± 6.5	26.1 ± 7.8	< 0.001
Gait speed, m/s	1.0 ± 0.3	0.8 ± 0.3	1.1 ± 0.2	< 0.001
Sit-to-stand, score	3.2 ± 1.2	2.5 ± 1.5	3.6 ± 0.9	< 0.001
Balance score	3.5 ± 0.9	3.1 ± 1.2	3.7 ± 0.6	< 0.001
Total SPPB score	10.4 ± 2.4	8.8 ± 3.1	11.2 ± 1.5	< 0.001

Date is presented mean ± standard deviation, median (25th to 75th), and number (percentage) of patients

BMI body mass index, *GNRI* geriatric nutritional risk index, *LoPAQ* low physical activity questionnaire, *kcal* kilocalories, *SPPB* short physical performance battery physical activity of 825.0 kcal/week (interquartile range [IQR], 369.4–1848.8 kcal/week) and walking activity of 315.0 kcal/week (IQR, 105.0–735.0 kcal/week). Pedometers recorded a median weekly step count of 23,090.5 (IQR, 10990.5–38275.5 steps/week) (Table 1). Patients with frailty (Fried scale ≥ 3 points) were significantly older; they were also mostly men, and more likely to have a lower BMI, lower GNRI, lower pre-dialysis serum creatinine, lower serum albumin, higher comorbidity index score, lower physical activity on the LoPAQ, and lower physical performance than those with non-frailty (Table 1).

Relationships between physical activity as reported by the LoPAQ and pedometer step counts

Table 2 shows the results of the relationship between LoPAQ activity and pedometer step counts. Overall, the total physical activity and walking activity on the LoPAQ significantly correlated with the pedometer step counts for both patients with frailty and non-frailty. However, sedentary time was not significantly correlated with step counts.

In addition, the multiple linear regression analysis showed that the LoPAQ total physical activity and walking activity were significantly associated with pedometer step counts even after adjustment for the covariates for both patients with frailty and non-frailty (Table 3). In contrast, sedentary time was significantly associated with step counts even after adjustment for the covariates for overall subjects, while it was marginally, but not significantly, associated with step counts for both patients with frailty and non-frailty (Table 3).

Screening values of the LoPAQ for frailty

Table 4 shows the AUC values. The AUC value for the LoPAQ total physical activity for frailty (Fried scale ≥ 3)

Table 2 Correlations between LoPAQ results and pedometer step counts

Pedometer steps (steps/week)	Overall		Frailty (≥ 3 points)		Non-frailty (< 3 points)	
	n = 220		*n* = 67		*n* = 153	
	Spearman's correlation	*P* value	Spearman's correlation	*P* value	Spearman's correlation	*P* value
LoPAQ total physical activity kcal	0.49	< 0.001	0.37	0.002	0.37	< 0.001
LoPAQ walking activity kcal	0.53	< 0.001	0.42	< 0.001	0.39	< 0.001
LoPAQ sedentary time	− 0.14	0.034	− 0.04	0.767	− 0.06	0.441

LoPAQ low physical activity questionnaire, *kcal* kilocalories

Table 3 Relationships between LoPAQ results and pedometer step counts after adjustment for covariates

Variables	Pedometer steps (steps/week)								
	Overall			Frailty			Non-frailty		
	β	(95% CI)	*P* value	*β*	(95% CI)	*P* value	*β*	(95% CI)	*P* value
Model 1									
LoPAQ total physical activity kcal	4.59	(2.93–6.25)	< 0.001	5.18	(2.50–7.86)	< 0.001	3.46	(1.60–5.33)	< 0.001
LoPAQ walking activity kcal	11.84	(8.42–15.27)	< 0.001	15.91	(7.43–24.39)	< 0.001	8.76	(5.01–12.51)	< 0.001
LoPAQ sedentary time	− 1083.03	(−1940.44 to −225.62)	0.014	− 540.45	(− 1600.31 to 519.41)	0.312	− 652.43	(− 1706.65 to 401.78)	0.223
Model 2									
LoPAQ total physical activity kcal	4.25	(2.61–5.88)	< 0.001	5.45	(2.67–8.23)	< 0.001	3.33	(1.47–5.19)	< 0.001
LoPAQ walking activity kcal	11.32	(7.96–14.67)	< 0.001	16.80	(8.05–25.55)	< 0.001	8.63	(4.91–12.35)	< 0.001
LoPAQ sedentary time	− 1013.03	(− 1846.80 to −179.27)	0.018	− 547.60	(− 1628.59 to 533.38)	0.315	− 608.60	(− 1653.83 to 436.63)	0.252

Multivariate Model 1 is adjusted for age, sex and body mass index

Multivariate Model 2 is adjusted for age, sex, body mass index, geriatric nutritional risk index, and comorbidity index

CI confidence interval, *LoPAQ* low physical activity questionnaire, *kcal* kilocalories

Table 4 Screening values of the LoPAQ for frailty

	LoPAQ total physical activity kcal		LoPAQ walking activity kcal		LoPAQ sedentary time		Pedometer with accelerometer	
	AUC	(95% CI)	AUC	(95% CI)	AUC	(95% CI)	AUC	(95% CI)
Frailty (≥ 3 vs < 3 points)	0.72	(0.64–0.79)	0.73	(0.65–0.79)	0.60	(0.51–0.67)	0.89	(0.83–0.93)

AUC area under the curve, *CI* confidence interval, *LoPAQ* low physical activity questionnaire, *kcal* kilocalories

was 0.72. Similarly, the AUC value for the LoPAQ walking activity for frailty was 0.73. However, sedentary time had no screening ability for frailty (AUC: 0.60).

Discussion

Our study data showed that physical activity calculated by the Japanese LoPAQ and the pedometer step counts were significantly correlated with patients overall and in patients with frailty. The LoPAQ total physical activity and walking activity were associated with pedometer step counts even after adjustment for the covariates. In addition, we found that the LoPAQ total physical activity and walking activity had moderate screening abilities for frailty. These results suggest that the Japanese LoPAQ is useful as a physical activity assessment tool and as a screening tool for frailty in patients on hemodialysis.

Our finding that the Japanese LoPAQ (total physical activity and walking activity) had a positive correlation ($r = 0.49–0.53$) with pedometer step counts is in line with the US study that examined the validity of the English LoPAQ (original version) in patients on dialysis [18]. In that study, LoPAQ results were compared with those obtained from an objective pedometer to confirm the utility of the LoPAQ in 60 patients on hemodialysis and peritoneal dialysis (PD), and a significant moderate ($r = 0.35–0.53$) positive correlation was reported between the LoPAQ (total physical activity and walking activity) and pedometer step counts [18]. Compared with that study, our patients were older (mean age: 67.8 vs. 58.0) and with a longer dialysis vintage (median years: 10.0 vs. 3.1). Thus, our study extends previous findings by reporting the validity of the LoPAQ in Japanese patients on hemodialysis as well as among older patients with longer dialysis vintages.

We also compared the physical performance of the patients in our study with the reported performance of the other study's patients in order to examine the external validity of the findings. Handgrip strength was lower (mean strength: 24.3 vs. 28.5) in our study, possibly because of the high percentage of men (78.3%) in the previous study [18]. In contrast, gait speed (mean speed: 1.0 vs. 0.9), sit-to-stand score (mean score: 3.2 vs. 3.0), balance score (mean score: 3.5 vs. 3.7), and total SPPB score (mean score: 10.4 vs. 10.0) were consistent with the previous study [18]. These comparisons indicate the generalizability of our findings.

We found that the LoPAQ had a moderate screening ability for frailty. Considering the Fried frailty criteria, which include the five objective markers of weight loss, grip strength, fatigue, gait speed, and physical activity, the LoPAQ could be a simple and useful marker for frailty. In epidemiologic studies, the modified Minnesota Leisure Time Activities Questionnaire is currently used to assess physical activity when assessing frailty. It takes approximately 20 min to administer and asks about engagement in 18 different activities [17]. In contrast, the LoPAQ consists of only 11 items, and takes approximately 10 min to administer [17]. Thus, the LoPAQ may be a shorter and easier marker for measuring frailty. In addition, the LoPAQ can assess the content of low-intensity physical activity, which is important in managing low activity and inactivity time in patients on hemodialysis, and the frequency of implementation of the activity. Such information can lead to treatment to prevent patients on hemodialysis from frailty.

The total physical activity and walking activity calculated by the LoPAQ were significantly correlated with objective step counts and demonstrated moderate screening abilities for frailty; however, sedentary time did not show any significant results in this study. Previous studies on community-dwelling older adults have also not reported any significant correlations between sedentary time measured objectively and by a questionnaire [27–29]. Therefore, it may not be enough to use questionnaires to assess daily sedentary time accurately.

In this study, the number of patients who completed the LoPAQ assessment ($n = 360$) was larger than the number who completed the pedometer assessment ($n = 260$). Similar results were observed in other studies that assessed physical activity using both pedometers and questionnaires [30, 31]. Objective pedometers may have disadvantages, such as non-wearability and participants' refusal to wear them. In contrast, a questionnaire has the advantage of being able to assess and manage the physical activity of more patients.

Our study has some limitations that should be addressed. First is the small sample size. However, the sample size was relatively larger than that of the previous study that validated the LoPAQ on 60 participants [18]. Second, the possibility of recall bias, social desirability bias, and misunderstanding of the intent of the questions of the LoPAQ cannot be excluded. Behavioral recall is a complex cognitive task [32]. The assessment of physical activity using the International Physical Activity Questionnaire in a previous study indicated that older people might misunderstand questions and have difficulty recalling behaviors accurately [33]. Given that the participants in this study included many older patients (70% were ≥ 65 years), these biases are likely to have occurred. Third, this study was conducted only in patients on hemodialysis, and we were not able to examine the screening ability of the LoPAQ in patients on PD. Since patients on PD have shorter dialysis time constraints daily, their lifestyle may be different from that of patients on hemodialysis, who, on an average, go to hospitals or clinics thrice a week as per their dialysis schedule. Therefore, it is necessary to further examine the LoPAQ's screening ability for frailty in patients on dialysis, including those on PD.

Conclusion

The Japanese version of the LoPAQ moderately correlated with step counts, even in patients on hemodialysis and those with frailty. In addition, the total physical activity and walking activity calculated by the LoPAQ were determined to have screening ability for frailty in patients on hemodialysis.

Abbreviations

LoPAQ	Low physical activity questionnaire
kcal	Kilocalories
BMI	Body mass index
GNRI	Geriatric nutritional risk index
SPPB	Short physical performance battery
AUC	Area under the curve
IQR	Interquartile range
PD	Peritoneal dialysis

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s41100-023-00514-y.

Additional file 1.The Japanese version of the LoPAQ.

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Author contributions

SY, SY, and AM conceptualized the analysis; SY, SY, MH, YS, KI, SY, SO, and AM collected data for the analysis; SY and SY wrote the manuscript; MH, YS, KI, SY, SO, and AM critically appraised the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials

Not applicable.

Declarations

Ethics approval and consent to participate

The study was performed according to the ethical principles of the Declaration of Helsinki and approved by the relevant Institutional Review Board/Ethics Committee of Kitasato University School of Allied Health Sciences (approval number: 2016-014). We explained the purpose of this study to all patients who met the eligible criteria. Among them, we included the patients who agreed to participate in our study. All the participants who were involved in this study had provided informed consent.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author details

[1]Department of Rehabilitation Sciences, Kitasato University Graduate School of Medical Sciences, Sagamihara, Kanagawa, Japan. [2]Department of Rehabilitation, Sagami Circulatory Organ Clinic, Sagamihara, Kanagawa, Japan. [3]Department of Epidemiology and Prevention, Center for Clinical Sciences, National Center for Global Health and Medicine, Tokyo, Japan. [4]Center for Outcomes Research and Economic Evaluation for Health, National Institute of Public Health, Wokō, Saitama, Japan. [5]Tokyo Metropolitan Institute for Geriatrics and Gerontology, Itabashi, Tokyo, Japan. [6]Department of Nephrology, Tokyo Ayase Kidney Center, Tokyo, Japan.

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