

Development and Evaluation of the Physical Activity Questionnaire for Elderly Japanese: The Nakanojo Study

**Akitomo Yasunaga, Hyuntae Park, Eiji Watanabe,
Fumiharu Togo, Sungjin Park, Roy J. Shephard,
and Yukitoshi Aoyagi**

The Physical Activity Questionnaire for Elderly Japanese (PAQ-EJ) is a self-administered physical activity questionnaire for elderly Japanese; the authors report here on its repeatability and direct and indirect validity. Reliability was assessed by repeat administration after 1 month. Direct validation was based on accelerometer data collected every 4 s for 1 month in 147 individuals age 65–85 years. Indirect validation against a 10-item Barthel index (activities of daily living [ADL]) was completed in 3,084 individuals age 65–99 years. The test–retest coefficient was high ($r = .64-.71$). Total and subtotal scores for lower (transportation, housework, and labor) and higher intensity activities (exercise/sports) were significantly correlated with step counts and durations of physical activity <3 and ≥ 3 METs ($r = .41, .28, .53$), respectively. Controlling for age and ADL, scores for transportation, exercise/sports, and labor were greater in men, but women performed more housework. Sex- and ADL- or age-adjusted PAQ-EJ scores were significantly lower in older and dependent people. PAQ-EJ repeatability and validity seem comparable to those of instruments used in Western epidemiological studies.

Key Words: aging, accelerometer measurements, epidemiology, reliability, self-reports, sex differences, validity

Physical activity can be assessed either subjectively or objectively. Objective determinations have used doubly labeled water, motion sensors, and heart-rate monitors, and subjective measurements have relied on diaries, questionnaires, or monitoring by trained observers. The former approach generally provides more accurate estimates of physical activity (Shephard, 2003). Problems of cost, however; the time invested by investigators and respondents; and logistic considerations generally limit the use of doubly labeled water, motion sensors, and heart-rate

Yasunaga is with the Faculty of Liberal Arts and Sciences, Bunka Women's University, Tokyo 187-0021 Japan. H. Park, Togo, S. Park, and Aoyagi are with the Tokyo Metropolitan Institute of Gerontology, Tokyo 173-0015 Japan. Watanabe is with the Faculty of Human Health Science, University of Hachinohe, Aomori 031-8566 Japan. Shephard is with the Faculty of Physical Education and Health, University of Toronto.

monitors to small and unrepresentative samples of any population (Washburn, 2000). This same criticism applies to the use of diaries and direct observation. Consequently, physical activity questionnaires are the only practical tool for large-scale epidemiological studies.

Since 2000, we have been conducting a longitudinal interdisciplinary study on the habitual physical activity and health of elderly people living in the medium-size residential town of Nakanojo, Gunma Prefecture, central Japan (the Nakanojo Study). To date, we have used accelerometer data to examine cross-sectional associations between objective assessments of the quantity and quality of yearlong physical activity and many measures of physical and mental health in a convenience sample of several hundred older adults. For example, we have shown that a depressive mood state and poor quality of life are less likely in elderly individuals who meet empirical minimum standards of habitual physical activity: $>4,000$ steps/day or >5 min/day at an intensity ≥ 3 metabolic equivalents (METs; Yasunaga et al., 2006; Yoshiuchi et al., 2006). We are now embarking on a more inclusive self-report survey of all of approximately 5,000 residents of this community age ≥ 65 years, to explore what minimum pattern of habitual physical activity is adequate to promote health, prevent disease, and delay functional loss. For this purpose, we need a valid Japanese-language questionnaire that will supplement our periodic accelerometer observations on a smaller subsample of the population.

At least five physical activity questionnaires are currently available for use in older individuals: the modified Baecke questionnaire (Voorrips, Ravelli, Dongelmans, Deurenberg, & Staveren, 1991), the Zutphen Physical Activity Questionnaire (Caspersen, Bloemberg, Saris, Merritt, & Kromhout, 1991), the Yale Physical Activity Survey (DiPietro, Caspersen, Ostfeld, & Nadel, 1993), the Physical Activity Scale for the Elderly (Washburn, Smith, Jette, & Janney, 1993), and the Community Healthy Activities Model Program for Seniors (Stewart et al., 2001). All five of these questionnaires were developed for U.S. or European populations, and in consequence some of the categories of physical activity that are discussed are inappropriate for older Japanese adults. Culture, age, and sex must all be considered when deciding on the specific content of a physical activity assessment tool (Kriska & Caspersen, 1997). Plainly, a simple translation of an American or European questionnaire cannot be used in the very different milieu of an Asian community.

The purpose of this study was thus to develop a physical activity questionnaire that was appropriate for elderly Japanese (PAQ-EJ) and to evaluate its test-retest reliability and its direct and indirect validity. Based on our extensive local observations and accelerometer data, we identified seven categories that would capture all significant bouts of physical activity in both the men and the women of this community; a simple form allowed participants to rate each of these items for frequency (days per week) and duration (minutes or hours/day) during a typical week in the preceding month. The 1-month test-retest reliability of scores was determined by repeat administration of the PAQ-EJ. Direct criterion-related validation compared PAQ-EJ scores with accelerometer assessments. Indirect construct-related validation assessed associations between PAQ-EJ scores and variables known to affect physical activity in the elderly, such as age, sex, and the ability to perform activities of daily living (ADLs).

Methods

Study Design and Participants

The study was conducted in Nakanojo, about 150 km northwest of Tokyo, as part of an extensive epidemiological study of this community. In 2004, the total population of Nakanojo was 17,942 (8,706 men and 9,236 women), 27.2% of whom were age ≥ 65 years (23.8% of men and 30.4% of women). Figure 1 illustrates the flow for selection of participants in the present study. Research assistants distributed the PAQ-EJ to 4,447 people (1,909 men and 2,538 women, all of the elderly population except those who were severely demented, bedridden, institutionalized, or hospitalized). All gave their written informed consent to take part in this institutionally approved study after the protocol, stresses, and possible risks had been fully explained to them. The forms were collected a couple of weeks later. Of potential respondents, 69.4% (3,084; 1,398 men and 1,686 women age 65–99 years) completed the PAQ-EJ (73.2% of men and 66.4% of women). One month later, a convenience sample of 147 participants (61 men and 86 women age 65–85 years) drawn from the same sample again completed the PAQ-EJ. This subgroup was chosen because they had also worn an accelerometer for the month preceding baseline administration of the PAQ-EJ.

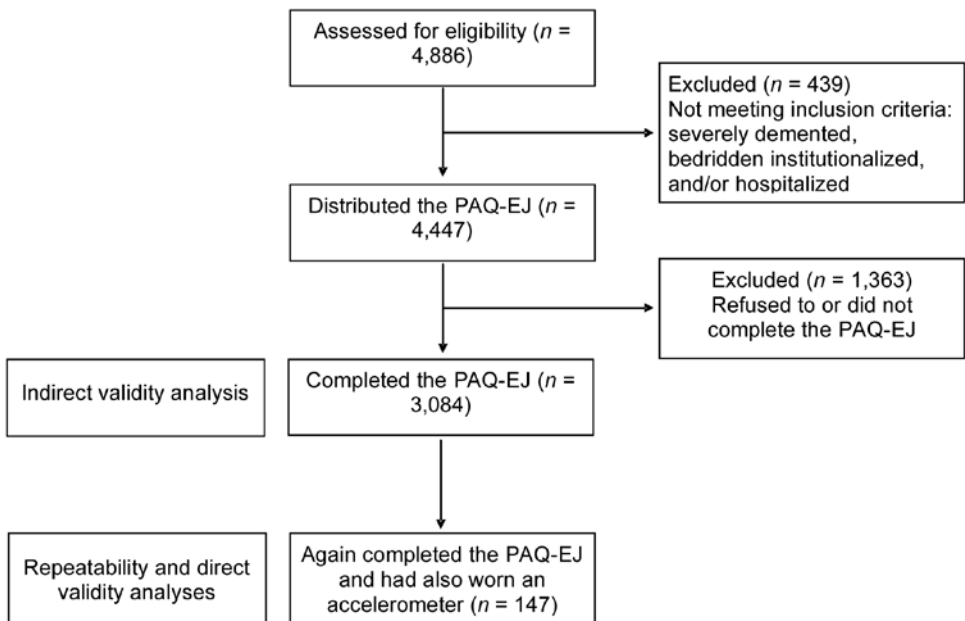


Figure 1 — Participant-selection flowchart. PAQ-EJ = Physical Activity Questionnaire for Elderly Japanese.

Measurement Tools

PAQ-EJ. The PAQ-EJ is a self-administered recall questionnaire that explores the frequency and duration of involvement in each of seven categories of physical activity during a typical week in the preceding month (Appendix 1 provides an approximate English translation of the instrument). It focuses on the four domains of physical activity common among elderly Japanese (and older people in many other parts of the world): personal transportation, exercise/sports (three subcategories of light, moderate or somewhat strenuous, and resistance), housework (two subcategories of light and moderate or somewhat heavy), and labor (work around the house or yard). For each category of physical activity, respondents indicate how often they performed this activity in a given week: never, seldom (1 or 2 days), sometimes (3 or 4 days), or often (5–7 days). They next indicate the time allocated to a given activity during a typical day. For transportation and moderate or somewhat strenuous and resistance exercise/sports, the options on the questionnaire are <30 min, 30 min to <1 hr, 1 to <2 hr, and ≥ 2 hr; for light exercise/sports, light and moderate or somewhat heavy housework, and labor, the corresponding categories are <1 hr, 1 to <2 hr, 2 to <4 hr, or ≥ 4 hr. The observers subsequently convert the categorical data to arbitrary scores, using midpoints for the stated frequency and duration of potential responses. The midpoints for frequency are *never* = 0, *seldom* = 1.5 days, *sometimes* = 3.5 days, and *often* = 6 days, and for the duration of effort, the corresponding midpoints are <30 min = 0.25 hr, <1 hr = 0.5 hr, 30 min to <1 hr = 0.75 hr, 1 to <2 hr = 1.5 hr, ≥ 2 hr = 2.5 hr, 2 to <4 hr = 3 hr, and ≥ 4 hr = 5 hr (for details, see Appendix 2).

To convert these arbitrary PAQ-EJ scores to MET hours per week, an intensity weight is assigned to each physical activity category, based on the accelerometer data and modified MET values for older adults as reported by Stewart et al. (2001). The weightings used for this purpose are transportation = 2.8 METs, light exercise/sports = 3.0 METs, moderate or somewhat strenuous exercise/sports = 4.3 METs, resistance exercise/sports = 3.0 METs, light housework = 2.0 METs, moderate or somewhat heavy housework = 2.5 METs, and labor = 2.8 METs (for further details, see Appendix 2). For the purposes of our study, weightings <3 and ≥ 3 METs were considered lower and higher intensities of effort, respectively.

Motion Detector. Details of the procedure and its reliability and validity have been described previously (Togo, Watanabe, Park, Shephard, & Aoyagi, 2005; Yasunaga et al., 2006). In brief, an electronic accelerometer with a storage capacity of 36 days (modified Kenz Lifecorder, Suzuken Co., Ltd., Nagoya, Aichi, Japan) was attached to a waist belt on either the left or right side of the body, and it was worn throughout each day for 1 month immediately before the first (baseline) administration of the PAQ-EJ. The accelerometer measured the number of steps taken and the intensity of physical activity every 4 s. After inspection of stored data for periods of inappropriate recording, step counts and intensity categories were totaled over each 24-hr period from midnight to the following midnight. Parameters calculated were the daily step count, averaged over the entire month, and the average daily periods of physical activity at a low intensity (<3 METs) and at an intensity higher than moderate for a typical elderly person (≥ 3 METs). These three variables are closely associated with total energy expenditure (Kumahara et al., 2004). Periods

of rest (1 MET) and sitting (or standing) activities <1.5 METs were excluded from our analysis, given that these are simply the residual of the observation period.

ADLs. The standard Barthel index examined 10 basic ADLs (Mahoney & Barthel, 1965): feeding, transfers from bed to chair and floor to chair, washing or grooming, toileting, bathing, walking on a level surface, climbing stairs, dressing and undressing, controlling bladder function, and controlling bowel function. Functional dependence was defined as a need for help in performing any of these ADLs.

Statistical Analyses

Nonpaired *t* tests analyzed sex differences in physical characteristics (age, height, body mass, and body-mass index) and the three selected physical activity-related variables (daily step count and durations of activity at an intensity of <3 and ≥3 METs). One-month test-retest reliability of the PAQ-EJ was assessed by calculating simple Pearson correlation coefficients between scores obtained from the two administrations of the test. To determine the PAQ-EJ's direct criterion-related validity, rank-ordered Spearman correlation analyses examined relationships between the total and subtotal PAQ-EJ scores for the four lower intensity and three higher intensity categories of physical activity and objective accelerometer assessments of step count and durations of physical activity at intensities <3 and ≥3 METs. Analyses of covariance (ANCOVAs) assessed the indirect construct-related validity of the PAQ-EJ in terms of independent associations of PAQ-EJ scores with sex (men vs. women after controlling for ADL and age), ADL (functional dependence vs. independence after controlling for sex and age), and age group (65–74 vs. 75–84 vs. 85–99 years after controlling for sex and ADL). All statistical contrasts were made at the .05 level of significance (Statistical Package for Social Science 11.5, SPSS Inc., Chicago). Data are presented as $M \pm SD$.

Results

Participant Characteristics

Respective physical characteristics of the 61 men and 86 women who took part in analyses of repeatability and direct validity of the PAQ-EJ were age 72.8 ± 3.9 and 72.8 ± 4.6 years, height 1.61 ± 0.06 and 1.48 ± 0.05 m, body mass 59.6 ± 7.4 and 51.1 ± 7.2 kg, and body-mass index 22.9 ± 2.8 and 23.2 ± 3.1 kg/m². Appropriate *t* tests showed the anticipated differences of height and body mass between men and women ($p < .05$), but age and body-mass index did not differ between sexes. The month-averaged step count and the month-averaged durations of physical activity <3 and ≥3 METs showed statistically nonsignificant trends favoring the men ($8,139 \pm 3,131$ vs. $7,432 \pm 3,040$ steps/day; 64.9 ± 23.6 vs. 59.9 ± 22.5 min/day; 22.3 ± 15.6 vs. 19.0 ± 12.8 min/day).

In the indirect analyses of validity, the 1,398 men were slightly but significantly younger than the 1,686 women (74.3 ± 6.3 vs. 75.7 ± 6.9 years, respectively). This was also true for comparisons of 2,612 independent versus 472 dependent individuals (74.1 ± 6.0 vs. 80.2 ± 7.8 years, respectively). The prevalence of physical

and functional dependence was 15.3% of all participants (10.9% for men; 19.0% for women; 7.0%, 17.6%, and 47.7% for those age 65–74, 75–84, and 85–99 years, respectively).

Repeatability and Direct Validity of the PAQ-EJ

Pearson correlation analyses showed a strong and statistically significant relationship between scores for the first and the second administrations of the PAQ-EJ, with only minor differences of repeatability between low- and moderate-intensity effort (for total score, $r = .70$; for the subtotal of lower intensity activity categories, $r = .64$; for the subtotal of higher intensity categories, $r = .71$).

Rank-ordered Spearman correlation analyses showed that the PAQ-EJ score was significantly and positively associated with the month-averaged daily step count, although on this measure correlations were greater for moderate- than for low-intensity effort. For the total questionnaire score, $r = .41$; for the correlation between the subtotal PAQ-EJ score for lower intensity activities (transportation, housework, and labor) and the objective month-averaged record for the daily duration of physical activity <3 METs, $r = .28$; and for the correlation between questionnaire estimate of higher intensity activities (exercise/sports) and objective measurements for the duration of activity ≥ 3 METs, $r = .53$ (Figure 2).

Indirect Validity of the PAQ-EJ

ANCOVA controlling for age and ADL showed that scores on four individual categories of physical activity (transportation, light and moderate or somewhat strenuous exercise/sports, and labor) and the subtotal PAQ-EJ score for the three higher intensity categories were all significantly higher for men than for women, but the reverse was true for scores on two specific categories (light and moderate or somewhat heavy housework) and the subtotal PAQ-EJ score for the four lower intensity categories of physical activity (Table 1). There were no significant sex differences in the resistance exercise/sports category or the total PAQ-EJ scores. After controlling for age and sex, all individual categories (except resistance exercise/sports) and the two subtotal and total PAQ-EJ scores were significantly higher in physically and functionally independent people than in those who were dependent; likewise, after controlling for sex and ADL, scores were higher in those age 65–74 years than in those age 75–84 or 85–99 years.

Discussion

The PAQ-EJ was designed for use in Japanese epidemiological studies. The intent was to rank individuals from the least to the most physically active rather than to make a precise estimate of absolute energy expenditure. Our analyses confirm that the test we have designed performs as well as most instruments used in an Occidental milieu with respect to test–retest reliability as seen in repeat administrations of the PAQ-EJ, direct validity relative to objective accelerometer assessments, and indirect validity as shown by the ability of the PAQ-EJ to capture variables known

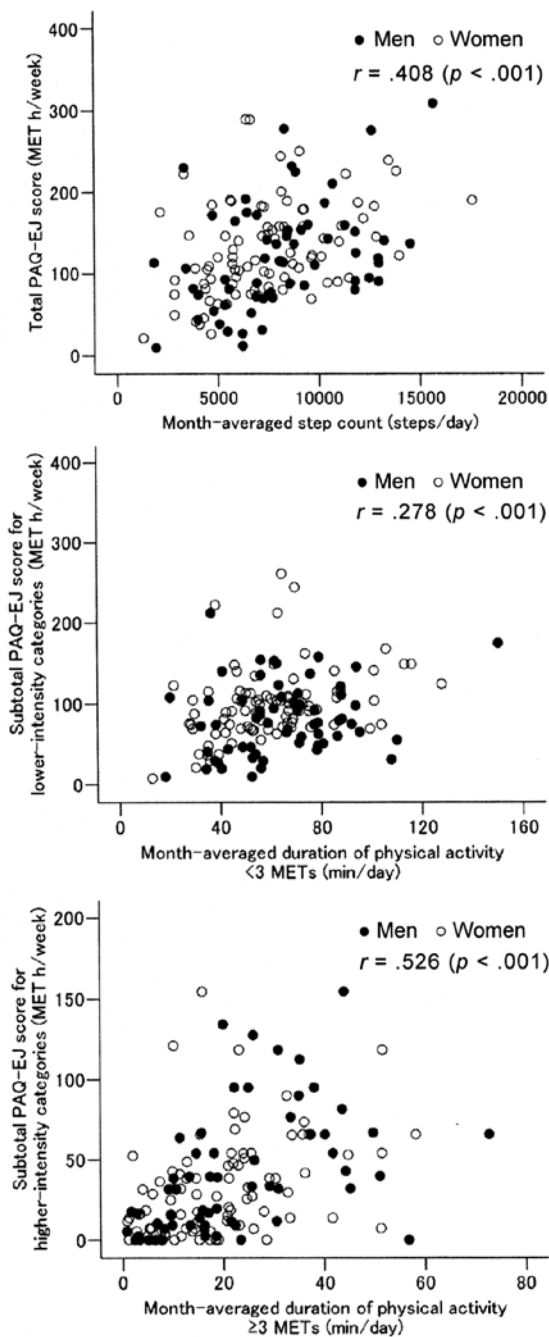


Figure 2 — Respective relationships between the total and subtotal PAQ-EJ scores for lower and higher intensity categories of physical activity and the month-averaged daily step count and durations of physical activity <3 and ≥ 3 metabolic equivalents (METs). $n = 61$ men, $n = 86$ women. PAQ-EJ = Physical Activity Questionnaire for Elderly Japanese.

Table 1 Influence of Sex, Activities of Daily Living, and Age Group on the PAQ-EJ Scores, *M* (*SD*), MET hr/Week

Variable	All	Age Group, Years					Significance		
		Men	Women	Independence	Dependence	1. 65–74		2. 75–84	3. 85–99
Number of Participants	3,084	1,398	1,686	2,612	472	1,604	1,149	331	
Total	79.3 (74.7)	79.4 (75.9)	79.2 (73.7)	85.8 (74.8)	43.2 (63.4)	91.2 (77.3)	75.6 (70.6)	34.6 (55.2)	1 > 2 > 3††
Subtotal of Lower Intensity Activities	61.2 (58.3)	58.4 (56.7)	63.6 (59.4)	66.2 (58.1)	33.6 (50.7)	70.7 (60.3)	58.0 (55.1)	26.7 (42.5)	1 > 2 > 3**††
All transportation	9.6 (12.2)	10.5 (13.5)	8.9 (10.9)	10.6 (12.5)	4.3 (8.6)	10.8 (12.5)	9.3 (12.0)	5.1 (9.4)	1 = 2 > 3**††
All housework	30.2 (35.3)	20.6 (31.1)	38.2 (36.5)	32.6 (35.8)	16.9 (28.8)	34.7 (36.9)	28.9 (34.1)	13.1 (23.0)	1 > 2 > 3**††
light housework	19.4 (20.8)	11.2 (16.2)	26.3 (21.8)	20.9 (21.1)	11.4 (17.4)	22.0 (21.7)	18.7 (20.2)	9.4 (15.0)	1 > 2 > 3**††
moderate or somewhat heavy housework	10.8 (19.3)	9.3 (18.0)	12.0 (20.3)	11.8 (19.9)	5.4 (14.6)	12.7 (20.6)	10.2 (18.6)	3.6 (11.7)	1 > 2 > 3**††
All labor	21.4 (29.8)	27.3 (31.9)	16.5 (27.1)	23.0 (30.4)	12.3 (24.6)	25.2 (31.6)	19.8 (28.4)	8.5 (20.7)	1 > 2 > 3**††
Subtotal of Higher Intensity Activities	18.1 (30.3)	21.0 (33.7)	15.6 (27.0)	19.6 (31.4)	9.6 (22.1)	20.5 (32.4)	17.6 (29.4)	7.9 (19.2)	1 = 2 > 3**††
All exercise/sports	18.1 (30.3)	21.0 (33.7)	15.6 (27.0)	19.6 (31.4)	9.6 (22.1)	20.5 (32.4)	17.6 (29.4)	7.9 (19.2)	1 = 2 > 3**††
light exercise/sports	11.6 (18.7)	13.6 (21.1)	10.0 (16.2)	12.6 (19.2)	6.5 (14.7)	12.6 (19.1)	11.9 (18.9)	6.2 (14.4)	1 = 2 > 3**††
moderate or somewhat strenuous exercise/sports	5.4 (12.2)	6.1 (13.4)	4.8 (11.1)	5.9 (12.8)	2.5 (8.3)	6.7 (13.2)	4.6 (11.7)	1.4 (6.6)	1 > 2 > 3**††
resistance exercise/sports	1.1 (4.8)	1.2 (5.3)	0.9 (4.3)	1.1 (5.0)	0.6 (3.3)	1.2 (5.2)	1.1 (4.7)	0.3 (2.0)	

Note. PAQ-EJ = Physical Activity Questionnaire for Elderly Japanese.

*Men vs. women ($p < .05$); †independence vs. dependence ($p < .05$); ††1. age 65–74 vs. 2. age 75–84 vs. 3. age 85–99 ($p < .05$).

to affect the physical activity of older adults (age, sex, and ADL). Other factors that could influence physical activity (socioeconomic state and educational level) were not explored in the present analyses, because interindividual differences in these characteristics are small in the general Japanese population of this age group. Further study is also needed to examine whether the questionnaire would be equally effective in a large urban community.

Most physical activity questionnaires for younger and healthier populations have focused on leisure and occupational physical activity and have not assessed involvement in less strenuous forms of physical activity such as housework, gardening, and casual walking (Kriska & Caspersen, 1997; Martin et al., 1998). Older or diseased populations do not engage in large amounts of vigorous physical activity, however, so the ability to capture interindividual differences in the volume of lower intensity physical activity is important to determining the total daily volume of physical activity and overall energy expenditure in the elderly (LaPorte et al., 1984). The PAQ-EJ was thus designed to assess the forms of light and moderate physical activity in which most older Japanese engage regularly during their daily living. Unlike some U.S. questionnaires intended for older populations, it excluded items such as competitive sports and strenuous exercise. The need for such items is questionable even in questionnaires designed for Western populations. Wareham et al. (2002) observed that in later middle age, more than half of an English sample (49 out of 84 male participants age 58.8 ± 7.9 years and 48 out of 89 female participants age 55.4 ± 6.7 years) did not participate in vigorous physical activity. Accelerometer data for our participants showed that there was almost no activity ≥ 6 METs in most individuals (an average of <1.0 min/day). Considerations of participant and observer time often require researchers to choose a brief survey that focuses on the physical activity most prevalent in a population (Kriska & Caspersen). Our experience in North American samples has been that the reliability and validity of information acquired from a brief questionnaire compare very favorably with those yielded by much longer instruments (Godin & Shephard, 1985). We thus decided that the PAQ-EJ should focus on no more than seven categories of physical activity, items that our observations and accelerometer data had shown to dominate the physical activity repertoire of elderly Japanese: personal transportation; light, moderate or somewhat strenuous and resistance exercise/sports; light and moderate or somewhat heavy housework; and labor or yard work.

In confirmation of earlier research (Ainsworth, Jacobs, & Leon, 1993; Godin & Shephard, 1985), the reliability and direct validity of our results ($r = .64-.71$ and $.28-.53$, respectively) are similar to or better than those reported for much more complicated questionnaires (DiPietro et al., 1993; Harada, Chiu, King, & Stewart, 2001; Wareham et al., 2002). In a small and likely atypical sample of 20 participants age 67–80 years, Washburn and Ficker (1999) reported that scores on the Physical Activity Scale for the Elderly were significantly associated ($r = .49$) with the average 3-day physical activity assessed by a portable accelerometer (Computer Science and Applications, Inc.; CSA). In another validity study on 40 Danish participants age 20–60 years, the correlation coefficient between the self-reported physical activity and the average 4-day objective measure of physical activity as assessed by the CSA accelerometer was only $.20$ (Aadahl & Jorgensen, 2003). Our data show that the total PAQ-EJ score and the subtotal score for higher intensity PAQ-EJ categories (activities to which weights of ≥ 3 METs were assigned) were

each modestly associated with objective data for the month-averaged daily step count and the duration of physical activity ≥ 3 METs, respectively. Relationships between the lower-intensity-activity PAQ-EJ scores (weightings < 3 METs) and the month-averaged daily duration of physical activity < 3 METs were also statistically significant, although as anticipated, they were weaker than for higher intensity activities. Two main factors explain this common finding: (a) It is more difficult to recall low-intensity (and more intermittent) physical activity than high-intensity exercise or sports (Stewart et al., 2001), although older adults are more likely to engage in the former type of physical activity (duration ratio = 3:1; Yasunaga et al., 2006), and (b) the accelerometer becomes less accurate when measuring low-intensity physical activity such as general household chores or yard work (Aadahl & Jorgensen; DiPietro et al.).

The current findings also offer an indirect validation of the PAQ-EJ and its ability to capture anticipated sex-, age-, and health-related differences in activity behavior. Previous studies have shown that whereas leisure-time and moderate or vigorous physical activity are more prevalent in men than in women (Caspersen, Pereira, & Curran, 2000; DiPietro, 2001), older women spend long periods indoors performing low-intensity household tasks (Kriska & Caspersen, 1997; Wareham et al., 2002). Our current results support this view; the PAQ-EJ scores for transportation, exercise/sports, and labor were, respectively, 18%, 35%, and 65% greater for men than for women, whereas the housework score was 85% higher for women than for men. The distribution of scores among the four main PAQ-EJ domains also showed sex differences; approximately 13%, 27%, 26%, and 34% of the total PAQ-EJ score were attributable to transportation, exercise/sports, housework, and labor in men, whereas in women, the corresponding figures were 11%, 20%, 48%, and 21%. Likewise, older or disabled persons are likely to be less active than younger or healthy individuals (Caspersen et al.; Harada et al., 2001; Washburn et al., 1993; Washburn & Ficker, 1999). In line with this expectation, our data showed that all categories (except resistance exercise/sports) and the resultant subtotal and total PAQ-EJ scores were significantly smaller in those who were older or dependent.

In conclusion, our data on the repeatability and validity of the PAQ-EJ suggest that it is a useful epidemiological tool for assessing the physical activity of older Japanese. Inferences about its reliability and validity, however, are necessarily limited to the population in whom it has been tested. Further research is needed to determine whether the PAQ-EJ is suitable for other older Asian populations, particularly those living in more urban or more rural areas, and whether it can be used over longer periods than we have tested (usual physical activity during the preceding month).

Acknowledgments

This research was undertaken as part of a longitudinal interdisciplinary study on the habitual physical activity and health of older adults living in Nakanojo, Gunma, Japan (the Nakanojo Study). The study was supported in part by a grant from the Japan Society for the Promotion of Science. The authors gratefully acknowledge the expert technical assistance of the research and nursing staffs of the Tokyo Metropolitan Institute of Gerontology and the Nakanojo Public Health Center. We would also like to thank the older adults whose participation made this investigation possible.

Correspondence concerning this article should be addressed to Yukitoshi Aoyagi, Ph.D., Exercise Sciences Research Group, Tokyo Metropolitan Institute of Gerontology, 35-2 Sakaecho, Itabashi-ku, Tokyo 173-0015, Japan. E-mail: aoyagi@tmig.or.jp; Tel: +81-3-3964-3241 ext. 3122; Fax: +81-3-3579-4776.

References

- Aadahl, M., & Jorgensen, T. (2003). Validation of a new self-report instrument for measuring physical activity. *Medicine and Science in Sports and Exercise*, *35*, 1196-1202.
- Ainsworth, B.E., Jacobs, D.R., Jr., & Leon, A.S. (1993). Validity and reliability of self-reported physical activity status: The Lipid Research Clinics questionnaire. *Medicine and Science in Sports and Exercise*, *25*, 92-98.
- Caspersen, C.J., Bloembergen, B.P.M., Saris, W.H.M., Merritt, R.K., & Kromhout, D. (1991). The prevalence of selected physical activities and their relation with coronary heart disease risk factors in elderly men: The Zutphen study, 1985. *American Journal of Epidemiology*, *133*, 1078-1092.
- Caspersen, C.J., Pereira, M.A., & Curran, K.M. (2000). Change in physical activity patterns in the United States, by sex and cross-sectional age. *Medicine and Science in Sports and Exercise*, *32*, 1601-1609.
- DiPietro, L. (2001). Physical activity in aging: Change in patterns and their relationship to health and function. *Journal of Gerontology*, *56*, 13-22.
- DiPietro, L., Caspersen, C.J., Ostfeld, A.M., & Nadel, E.R. (1993). A survey for assessing physical activity among older adults. *Medicine and Science in Sports and Exercise*, *25*, 628-642.
- Godin, G., & Shephard, R.J. (1985). A simple method to assess exercise behavior in the community. *Canadian Journal of Applied Sport Science*, *10*, 141-146.
- Harada, N.D., Chiu, V., King, A.C., & Stewart, A.L. (2001). An evaluation of three self-report physical activity instruments for older adults. *Medicine and Science in Sports and Exercise*, *33*, 962-970.
- Kriska, A.M., & Caspersen, C.J. (1997). Introduction to a collection of physical activity questionnaire. *Medicine and Science in Sports and Exercise*, *29*, S5-S9.
- Kumahara, H., Schutz, Y., Ayabe, M., Yoshioka, M., Yoshitake, Y., Shindo, M., et al. (2004). The use of uniaxial accelerometry for the assessment of physical-activity-related energy expenditure: A validation study against whole-body indirect calorimetry. *British Journal of Nutrition*, *91*, 235-243.
- LaPorte, R.E., Adams, L.L., Savage, D.D., Brenes, G., Dearwater, S., & Cook, T. (1984). The spectrum of physical activity, cardiovascular disease and health: An epidemiologic perspective. *American Journal of Epidemiology*, *102*, 507-517.
- Mahoney, F.I., & Barthel, D.W. (1965). Functional evaluation: The Barthel index. *Maryland State Medical Journal*, *14*, 61-65.
- Martin, K.A., Rejeski, W.J., Miller, M.E., James, M.K., Ettinger, W.H., Jr., & Messier, S.P. (1998). Validation of the PASE in older adults with knee pain and physical disability. *Medicine and Science in Sports and Exercise*, *31*, 627-633.
- Shephard, R.J. (2003). Limits to the measurement of habitual physical activity by questionnaire. *British Journal of Sports Medicine*, *37*, 197-206.
- Stewart, A.L., Mills, K.M., King, A.C., Haskell, W.L., Gillis, D., & Pitter, P.L. (2001). CHAMPS physical activity questionnaire for older adults: Outcomes for interventions. *Medicine and Science in Sports and Exercise*, *33*, 1126-1141.
- Togo, F., Watanabe, E., Park, H., Shephard, R.J., & Aoyagi, Y. (2005). Meteorology and the physical activity of the elderly: The Nakanojo Study. *International Journal of Biometeorology*, *50*, 83-89.

- Voorrips, L.E., Ravelli, A.C.J., Dongelmans, P.C.A., Deurenberg, P., & Staveren, W.A.V. (1991). A physical activity questionnaire for the elderly. *Medicine and Science in Sports and Exercise*, 23, 974-979.
- Wareham, N.J., Jakes, R.W., Rennie, K.L., Mitchell, J., Hennings, S., & Day, N.E. (2002). Validity and repeatability of the EPIC-Norfolk physical activity questionnaire. *International Journal of Epidemiology*, 31, 168-174.
- Washburn, R.A. (2000). Assessment of physical activity in older adults. *Research Quarterly for Exercise and Sport*, 71, 79-88.
- Washburn, R.A., & Ficker, J.L. (1999). Physical Activity Scale for Elderly (PASE): The relationship with activity measured by a portable accelerometer. *Journal of Sports Medicine and Physical Fitness*, 39, 336-340.
- Washburn, R.A., Smith, K.W., Jette, A.M., & Janney, C.A. (1993). The physical activity scale for the elderly (PASE): Development and evaluation. *Journal of Clinical Epidemiology*, 46, 153-162.
- Yasunaga, A., Togo, F., Watanabe, E., Park, H., Shephard, R.J., & Aoyagi, Y. (2006). Year-long physical activity and health-related quality of life in older Japanese adults: The Nakanajo study. *Journal of Aging and Physical Activity*, 14, 288-301.
- Yoshiuchi, K., Nakahara, R., Kumano, H., Kuboki, T., Togo, F., Watanabe, E., et al. (2006). Yearlong physical activity and depressive symptoms in older Japanese adults: Cross-sectional data from the Nakanajo Study. *American Journal of Geriatric Psychiatry*, 14, 621-624.

Appendix 1: English Translation of the Physical Activity Questionnaire for Elderly Japanese

This questionnaire is about activities (transportation, exercise/sports, housework, and labor) that you may have carried out **in a typical week** (e.g., without going on a trip) **during the past month**.

If you **DID NOT** do the activity:

Circle number 1, Never (0 day), and move on to the next question.

If you **DID** the activity:

Circle *how often in a week* (DAYS) and *how many AVERAGE HOURS a day* you usually did it.

[Transportation] Over 7 typical days, how often did you take a walk or ride a bicycle on errands such as going to or from a store or taking children to school?

- | | |
|----------------------------|-------------------------|
| 1. Never (0 days) | 2. Seldom (1 or 2 days) |
| 3. Sometimes (3 or 4 days) | 4. Often (5–7 days) |

On average, how many hours per day did you spend walking or cycling for these reasons?

- | | |
|----------------------------------|-------------------------------------|
| 1. Less than 30 minutes | 2. 30 minutes, but less than 1 hour |
| 3. 1 hour, but less than 2 hours | 4. 2 or more hours |

[Light exercise/sports] Over 7 typical days, how often did you participate in light sport and recreational activities such as leisurely walking for exercise or pleasure, stretching or flexibility exercises, golf, gateball, etc?

- | | |
|----------------------------|-------------------------|
| 1. Never (0 days) | 2. Seldom (1 or 2 days) |
| 3. Sometimes (3 or 4 days) | 4. Often (5–7 days) |

On average, how many hours per day did you engage in these light sport and recreational activities?

- | | |
|-----------------------------------|----------------------------------|
| 1. Less than 1 hour | 2. 1 hour, but less than 2 hours |
| 3. 2 hours, but less than 4 hours | 4. 4 or more hours |

[Moderate or somewhat strenuous exercise/sports] Over 7 typical days, how often did you participate in moderate or somewhat strenuous sport and recreational activities such as walking fast or briskly for exercise, dance, tennis, jogging, swimming, skiing, etc?

- | | |
|----------------------------|-------------------------|
| 1. Never (0 days) | 2. Seldom (1 or 2 days) |
| 3. Sometimes (3 or 4 days) | 4. Often (5–7 days) |

On average, how many hours per day did you engage in these moderate or somewhat strenuous sporting and recreational activities?

- | | |
|----------------------------------|-------------------------------------|
| 1. Less than 30 minutes | 2. 30 minutes, but less than 1 hour |
| 3. 1 hour, but less than 2 hours | 4. 2 or more hours |

[Resistance exercise/sports] Over 7 typical days, how often did you perform any exercises specifically to increase muscle strength and endurance, such as lifting handheld weights, using weight machines or elastic bands, etc?

- | | |
|----------------------------|-------------------------|
| 1. Never (0 days) | 2. Seldom (1 or 2 days) |
| 3. Sometimes (3 or 4 days) | 4. Often (5–7 days) |

On average, how many hours per day did you engage in these resistance activities?

- | | |
|----------------------------------|-------------------------------------|
| 1. Less than 30 minutes | 2. 30 minutes, but less than 1 hour |
| 3. 1 hour, but less than 2 hours | 4. 2 or more hours |

[Light housework] Over 7 typical days, how often did you carry out any light household activities such as dusting, sweeping or vacuuming, cooking, washing dishes, watering plants, etc?

- | | |
|----------------------------|-------------------------|
| 1. Never (0 days) | 2. Seldom (1 or 2 days) |
| 3. Sometimes (3 or 4 days) | 4. Often (5–7 days) |

On average, how many hours per day did you engage in these light household activities?

- | | |
|-----------------------------------|----------------------------------|
| 1. Less than 1 hour | 2. 1 hour, but less than 2 hours |
| 3. 2 hours, but less than 4 hours | 4. 4 or more hours |

[Moderate or somewhat heavy housework] Over 7 typical days, how often did you carry out any moderate or somewhat heavy household activities such as washing windows, scrubbing floors, outdoor gardening, yard care including snow or leaf removal, doing home carpentry or repairs like painting, wallpapering, etc?

- | | |
|----------------------------|-------------------------|
| 1. Never (0 days) | 2. Seldom (1 or 2 days) |
| 3. Sometimes (3 or 4 days) | 4. Often (5–7 days) |

On average, how many hours per day did you engage in these moderate or somewhat heavy household activities?

- | | |
|-----------------------------------|----------------------------------|
| 1. Less than 1 hour | 2. 1 hour, but less than 2 hours |
| 3. 2 hours, but less than 4 hours | 4. 4 or more hours |

[Labor] Over 7 typical days, how often did you do any laborious activities such as agricultural spading, raking, etc?

- | | |
|----------------------------|-------------------------|
| 1. Never (0 days) | 2. Seldom (1 or 2 days) |
| 3. Sometimes (3 or 4 days) | 4. Often (5–7 days) |

On average, how many hours per day did you engage in these laborious activities?

- | | |
|-----------------------------------|----------------------------------|
| 1. Less than 1 hour | 2. 1 hour, but less than 2 hours |
| 3. 2 hours, but less than 4 hours | 4. 4 or more hours |

Appendix 2: Scoring of the Physical Activity Questionnaire for Elderly Japanese (PAQ-EJ)

Category	Code
Number of days per week	
never (0 days)	0
seldom (1 or 2 days)	1.5
sometimes (3 or 4 days)	3.5
often (5–7 days)	6
Time per day	
less than 30 min	0.25
less than 1 hr	0.5
30 min, but less than 1 hr	0.75
1 hr, but less than 2 hr	1.5
2 or more hr	2.5
2 hr, but less than 4 hr	3
4 or more hr	5
Intensity weight assigned to physical activity	
transportation	2.8
light exercise/sports	3.0
moderate or somewhat strenuous exercise/sports	4.3
resistance exercise/sports	3.0
light housework	2.0
moderate or somewhat heavy housework	2.5
labor	2.8

Note. PAQ-EJ score (MET hr/week) = number of days × time × intensity weight.