Assessment of Physical Activity in Older Adults

Richard A. Washburn

**Keywords:** physical activity, older adults, questionnaires, reliability, validity

During the past 10 to 15 years the association of physical activity, a modifiable behavioral factor, and the risk for chronic disease and functional decline in older individuals has received increased research attention (Heckler, 1985). Over ten years ago, data from the Alameda County Study showed that, among the elderly, participation in leisure time physical activity was associated with a decreased risk of mortality over a 17-year follow-up, that was independent of age, socioeconomic status, health status, smoking, relative weight and alcohol consumption (Kaplan, Seeman, Cohen, Knudsen & Guralnik, 1987). More recently, physical activity has been associated with a decreased risk for cardiovascular mortality in elderly Spanish men and women (Ruizgomez, Alonso & Anto, 1995), both cardiovascular and all-cause mortality in elderly Dutch men (Bijnen, Caspersen, et al., 1998), and with the incidence of coronary heart disease in middle-aged and elderly Japanese American men living in Hawaii (Donahue, Abbott, Reed, & Yano, 1988). In addition, reports from the Established Populations for Epidemiologic Studies of the Elderly cohort have shown increased physical activity was significantly associated with a longer life expectancy at age 65 in both men and women, smokers and non-smokers (Ferrucci et al., 1999), with fewer years of disability prior to death (Leveille, Guralnik, Ferrucci, & Langlois, 1999), and with a decreased risk of losing mobility (LaCroix, Guralnik, Berkman, Wallace, & Satterfield, 1993). Maintaining a physically active lifestyle in later years has also been associated with a decreased risk for falls and hip fractures (Buchner et al., 1997; Campbell et al., 1997a; Joakimson, Magus, & Fonno, 1997; Province et al., 1995; Slemenda, 1997), as well as slowing the age-associated declines in bone mass (Graffman, Bouter, & Lips, 1998; Snow-Harter & Marcus, 1991; Wolff, van Cronenberg, Kemper, Kostense, & Twisk, 1999) and muscular strength (Jette et al., 1999; Rantanen, Era, & Heikkinen, 1997; Tracy et al., 1999).

While considerable evidence regarding the importance of physical activity in maintaining health and functional ability in older people has accumulated, a number of important questions remain. Do the current public health recommendations for physical activity and health, that every U.S. adult accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week (Pate et al., 1995), provide optimal health benefits for individuals over age 65? Does the type, amount, and intensity of physical activity necessary to decrease the risk of chronic diseases such as stroke, coronary heart disease, diabetes or osteoporosis, or with the maintenance of functional capabilities in older individuals differ across outcomes? What are the demographic and psychosocial correlates of physical activity participation in older people? What are the best strategies to promote physical activity in older individuals? To adequately address these, as well as other, issues related to the association of physical activity and health in older people, it is essential that methods for physical activity assessment be developed that are suitable for use in epidemiologic studies of this age group.

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Physical Activity Assessment Options

Physical activity can be assessed by a variety of techniques such as motion sensors (Freedson, Melanson, & Sirard, 1998; Tryon & Williams, 1996), heart rate monitoring (Livingstone, 1997; Mattiasson-Nilo et al., 1990), activity diaries (Bouchard et al., 1983; Carp & Carp, 1981; Kalkwarf, Haas, Belko, Roach, & Roe, 1989), doubly labeled water (Scholler et al., 1986; Starling, Toth, Carpenter, Mathews & Poehlman, 1998), and activity questionnaires (Pereira et al., 1997). Problems with cost, both financial and in terms of investigator and respondent burden, and logistical considerations, generally limit the use of motion sensors, heart rate monitoring, doubly labeled water and activity diaries to studies of small non-representative samples of older individuals. The physical activity questionnaire is currently the only assessment method that is feasible for use in large-scale epidemiologic studies. Physical activity questionnaires designed and validated for use in younger samples are frequently used in studies of older individuals (Gentry et al., 1985; Paffenbarger, Wing, & Hyde, 1978; Sallis et al., 1985; Taylor et al., 1978), however this practice may be inappropriate since the focus of most age-neutral physical activity questionnaires is on sport and recreational activity which has been shown to comprise a relatively small portion of the daily physical activity in older individuals (Washburn, Jette, & Janney, 1990; Yusuf et al., 1996). For example, Washburn et al. (1990) reported an average of only 5.4 minutes/day spent in sport and recreational activity, assessed by a 3-day activity diary, in 123 community dwelling individuals over age 65. Several reports have suggested that physical activity questionnaires designed primarily for use with young and middle-aged samples are inaccurate when used with older people (Cartmel & Moon, 1992; Starling et al., 1998; Washburn et al., 1990). Washburn et al. (1990) compared responses from the age-neutral Centers for Disease Control Behavioral Risk Factor Surveillance System questionnaire (Gentry et al., 1985) with physical activity estimates from a 3-day activity diary in 123 community dwelling volunteers, aged 65-91 years. In this sample, the age-neutral questionnaire underestimated the time spent in physical activity by approximately 2 hours 45 minutes per day. The magnitude of the absolute reporting error by questionnaire was small for strenuous activities (approximately 5 minutes per day) but was substantial (2 hours 20 minutes per day) for less strenuous physical activity categories (i.e. walking, household chores, light sport and recreation). Starling et al. (1998), in 99 men and women, mean age approximately 68 years, found a small and non-significant correlation \( r = 0.21 \) between physical activity assessed by the age-neutral Minnesota Leisure Time Physical Activity Survey (Taylor et al., 1978) and total energy expenditure over a 10-day period measured by the doubly labeled water technique. To date, only four physical activity questionnaires, the Modified Baecke Questionnaire for Older Adults (Voorrips, Ravelli, Dongelmans, Deurenberg, & Van Staveren, 1993b), the Zutphen Physical Activity Questionnaire (Caspersen, Bloemborg, Saris, Merritt, & Kromhout, 1991), the Yale Physical Activity Survey (DiPietro, Caspersen, Ostfeld, & Nadel, 1993), and the Physical Activity Survey for the Elderly (Washburn, Smith, Jette, & Janney, 1993), have been developed specifically for the assessment of physical activity in the elderly. Table 1 presents the major features of these questionnaires. Copies of each questionnaire can be obtained from Pereira et al. (1997). The purpose of this paper is to describe the basic characteristics of these surveys and review the published evidence regarding their reliability and both direct and indirect evidence for their validity. We considered associations of physical activity assessed by questionnaire, with physical activity assessed by other methods, such as activity diaries, motion sensors, heart rate monitoring, doubly labeled water, dietary intake, etc. to provide direct evidence for validity, while the association of physical activity assessed by questionnaire with variables influenced by physical activity such as, resting heart rate, maximal oxygen uptake, muscular strength, body composition, coronary heart disease mortality, etc. to provide indirect evidence for validity. In addition, a summary of the state of physical activity questionnaires for use in older adult populations and recommendations for future work in this area will be presented.

Modified Baecke Questionnaire for Older Adults

This survey is a modification of the original Baecke Survey which was developed and validated in Holland on 139 men and 167 women, age range 20 to 32 years (Baecke, Burema & Brijters, 1982). The original Baecke Survey has been used in several large epidemiologic studies (Pereira et al., 1999; Sternfeld, Ainsworth, & Quesenberry, 1999). The motivation behind modifying the original Baecke survey for use with older adults was to develop a survey that could discriminate between physically active and inactive individuals for a study on dietary intake and nutritional status in healthy, independent living older persons. The original Baecke survey included assessment of occupational, leisure time, and sport activity and was self-administered. In the modification for use with older individuals, the occupational activity component was replaced by assessment of household activity and the survey was re-designed to be administered by personal interview. The Modified Baecke Questionnaire for Older Adults consists of 12 items. The score from this questionnaire is unitless, although items are weighted by a factor based on the energy cost of a particular activity.
Validity - Direct Evidence

The validity of the Modified Baecke Questionnaire for Older Adults was assessed in apparently healthy, independent living Dutch volunteers, 14 men (mean age 73 ± 7 (SD) yrs) and 17 women (mean age 69 ± 5 yrs), recruited from sport clubs, associations for the elderly, and advertisements (Voorrips, Ravelli, et al. 1993). Scores from the Modified Baecke Questionnaire were compared with the mean physical activity score obtained from three 24-hour physical activity recalls, and physical activity measured over 3 days with a mechanical pedometer. The 24-hour recalls were performed on 2 randomly selected weekdays and 1 weekend day. The score from the recall procedure (mean net energy expenditure per day) was calculated by multiplying the number of minutes spent on each activity by the net energy expenditure (total energy expenditure minus resting energy expenditure) per minute for each activity. The pedometer score (mean counts per day) was the mean of data collected on three consecutive days (two weekdays and one weekend day). The validity of the Modified Baecke Questionnaire was assessed by determining the level of agreement between tertile classifications based on the Modified Baecke Questionnaire with the tertile classifications based on both the 24-hour recall procedure and pedometer scores, and by calculating Spearman correlations between the Modified Baecke Questionnaire and the 24-hour recall and pedometer scores. Results indicated that 22 of the 31 participants (71%) were correctly classified by the Modified Baecke Questionnaire when compared with the 24-hour recall (Kendall's tau = 0.66). When compared with the pedometer score, the Modified Baecke Questionnaire correctly classified 20 of the 30 participants (67%, Kendall’s tau = 0.68). Spearman correlations between Modified Baecke Questionnaire scores and 24-hour recall and pedometer scores were 0.78 and 0.72, respectively.

Validity - Indirect evidence

The Modified Baecke Questionnaire has been used in studies on the descriptive epidemiology of physical activity and weight and dietary issues in elderly Dutch men and women. Van den Hombergh et al. (1995) reported physical activity assessed by the Modified Baecke Questionnaire in 503 women and 493 men, ages 65-84 years, was associated with age, socioeconomic and marital status, disability, subjective health, presence of chronic diseases, living in a house with stairs, and living close to shopping areas. Higher levels of physical activity assessed by the Modified Baecke Questionnaire have been associated with lower body weight and body mass index (Voorrips, Lemmink, Van Heuvelen, Bult, & Van Staveren, 1993; Voorrips, Meijers, Sol, Seidell, & van Staveren, 1992; Voorrips, van Staveren, & Hautvast, 1991), better dietary habits (Voorrips et al., 1991), better flexibility of the hip and spine, and better cardiovascular endurance during a walking test (Voorrips, Lemmink, et al., 1993) in older Dutch women.

<table>
<thead>
<tr>
<th>Survey Name</th>
<th>Primary Reference</th>
<th>Activity Components</th>
<th>Recall Time frame</th>
<th>Administration Mode</th>
<th>Outcome Variable</th>
<th>Number of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zuphen Physical Activity</td>
<td>Caspersen et al., Am J Epidemiol, 1991</td>
<td>Leisure</td>
<td>Past-week</td>
<td>Self-administered</td>
<td>Caloric expenditure (kcal/kg/day)</td>
<td>15</td>
</tr>
<tr>
<td>Physical Activity Scale for the Elderly</td>
<td>Washburn et al., J Clin Epidemiol, 1993</td>
<td>Leisure, Occupation, Household</td>
<td>Past 7 days</td>
<td>Interview or Self-administered</td>
<td>Unitless activity Score</td>
<td>10</td>
</tr>
</tbody>
</table>
Reliability

Test-retest reliability over a 20-day interval was assessed in apparently healthy, independent living Dutch volunteers, 12 men (mean age 70 ± 4) and 17 women (mean age 71 ± 5 years), recruited in the same manner as the validity sample described previously (Voorrips, Lemmink, et al. 1993). The Modified Baecke Questionnaire was administered twice by the same observer. The difference in the mean Modified Baecke Questionnaire activity score over the two test administrations was not statistically significant (test 1 = 11.0 ± 4.6; test 2 = 11.4 ± 4.6). Results indicated 21 of 29 participants (72%) were classified in the same tertile of activity on both tests (Kendall’s tau = 0.74). The Spearman correlation between the first and second tests was 0.89.

Zutphen Physical Activity Questionnaire

The Zutphen Physical Activity Questionnaire (Caspersen et al., 1991), designed for use in the Netherlands cohort of the Seven Countries Study, is a modification of an unpublished questionnaire developed by Professor J.N. Morris of the London School of Hygiene and Tropical Medicine, originally designed for use in retired men. Information is requested regarding leisure time activities (walking, bicycling, gardening, hobbies and sports) over the past week or month. All time estimates are converted to hours per day and multiplied by an exercise intensity code (kcal/kg/hr) to yield a summary score in units of kcal/kg/day.

Validity - Direct Evidence

Only one published report (abstract) provides direct evidence for the validity of the Zutphen Questionnaire. Westerterp et al. (1992) compared physical activity measured with the Zutphen Questionnaire with a physical activity index derived from physical activity measured over a 14-day period by doubly labeled water divided by resting metabolic rate (measured twice during the 14-day period) in 21 Dutch men, mean age approximately 74 years. The correlation between the measured physical activity index and the activity assessed with the Zutphen Questionnaire was 0.61 (p < 0.01).

Validity - Indirect Evidence

Indirect evidence for the validity of the Zutphen Questionnaire comes from epidemiologic studies which report associations between physical activity assessed with this instrument and risk factors for cardiovascular disease, cardiovascular and all-cause mortality, and changes in physical activity with aging. In a representative sample of 863 Dutch men, age 65-84 years, Caspersen et al. (1991) reported a significant association between the total weekly time spent in physical activity as assessed by the Zutphen Questionnaire and age (r = -0.28, p < 0.001). Multiple regression analysis, in the same study sample, indicated that walking activity was an independent predictor of total cholesterol, while gardening activity was an independent predictor of total cholesterol, HDL cholesterol, and systolic blood pressure. Bijnen, Feskens, et al. (1998) in a 10 year follow-up of physical activity participation in this sample, whose baseline measures were obtained in 1985, documented a 39% (28 minutes per day) decrease in the mean total time spent engaged in physical activity as assessed by the Zutphen Questionnaire.

Bijnen et al. (1996) assessed physical activity using the Zutphen Questionnaire in 1,402 men, age 69-90 years who were members of the Finnish, Italian, and Dutch cohorts of the Seven Countries Study. Total physical activity was inversely associated with resting heart rate (r = -0.11, p < 0.001) and positively associated with HDL cholesterol (r = 0.08, p < 0.01) after adjustment for age, cohort, smoking, body mass index, and alcohol intake. No significant associations were noted between physical activity measured by the Zutphen Questionnaire and total cholesterol, non-HDL cholesterol, blood pressure, or body mass index.

In a study of 389 men, age 70-89 years, who participated in the Zutphen Elderly Study, Feskens et al. (1994) reported that insulin levels during an oral glucose tolerance test were lowest in men with the highest level of physical activity assessed with the Zutphen Questionnaire. This association was independent of age, body mass index, ratio of subscapular to triceps skinfold thickness, cigarette smoking, and energy intake. Bijnen, Caspersen, et al. (1998), in a 10-year follow up of 802 Dutch men, aged 64 to 84 years at baseline, reported a significant association for tertiles of time spent walking or cycling at least 3 times per week for 20 minutes assessed by the Zutphen Questionnaire and mortality from cardiovascular disease (Relative risk (RR) = 0.69, 95% confidence interval (CI) = 0.50-0.88) and all-cause mortality (RR = 0.71, 95% CI = 0.58-0.88) after adjustment for age at baseline, presence of major chronic diseases, cigarette smoking, and alcohol consumption.

Reliability

Westerterp et al. (1992), assessed test-retest reliability over a 4 month period in the sample of older Dutch men (N = 21, age 65-84 years) who participated in the validity study described previously. The correlation between the two test administrations was 0.93 (p < .001).
Yale Physical Activity Survey

The Yale Physical Activity Survey is a 36 item, interviewer administered survey that assesses exercise, household and recreational activity during a typical week in the past month. The types of activities included in the survey were determined by conducting open-ended interviews with 222 older volunteers recruited from urban and suburban senior centers and senior residential communities in Connecticut (DiPietro et al. 1993). The Yale Survey has two major sections. The first section requests information regarding the amount of time (hours/week) respondents participated in housework, yard work, caretaking, exercise and recreational activities during a typical week in the past month. The second section inquires about the frequency and duration of vigorous activity, leisurely walking, moving about, standing, and sitting during the past month. Three summary indices; total time, energy expenditure, and activity dimensions, can be calculated. The total time summary index is calculated as the sum of the time spent on all activities reported in section one and is expressed as hours per week. An energy expenditure index (kcal/week) can also be calculated from information in section 1 by multiplying the minutes of reported activity by an intensity code (kcal/min) associated with that activity and summing over all activities. The activity dimension index, for the dimensions of activity reported in section 2, is calculated by multiplying the reported frequency and duration by an arbitrary weighting factor based on the relative intensities of the each activity dimensions, and summed across all activities to create a summary index. Each activity dimension score can also be used separately.

Validity - Direct Evidence

Campbell et al. (1997b) provided evidence for the validity of the Yale Physical Activity Survey by comparing energy expenditure estimated from a 14-week measurement of dietary intake in a weight stable, volunteer sample of 9 women, mean age 67 ± 9 years, with energy expenditure estimated from the Yale Survey. Energy expenditure from physical activity by dietary intake was calculated as total energy intake minus the resting energy expenditure (indirect calorimetry) and the thermic effect of feeding (estimated as 10% of total energy intake). The mean energy expenditure from physical activity was similar for the two methods (dietary intake = 760 kcal/day, Yale Survey = 759.5 kcal/day, r = 0.94, p < 0.002), however, there was substantial variability in individual results ranging from a 17% over estimation to a 37% under estimation by the Yale Survey compared with dietary intake.

Sparrling et al. (1999) compared physical activity energy expenditure obtained from the Yale Physical Activity Survey with estimates of energy expenditure from doubly labeled water over a 10-day period in 35 women and 32 men, age range 45-84 years. No significant differences were observed between daily physical activity measured by the Yale Survey and doubly labeled water (DLW) in either men (DLW = 1,211 ± 429; Yale Survey = 1,107 ± 612 kcal/day) or women (DLW = 873 ± 244; Yale Survey = 863 ± 477 kcal/day). However, the individual variability in the concordance between physical activity measured by the Yale Survey and DLW were large (-1,310 to 1,518 kcal/day). The authors suggested that “Although the YPAS compares favorably with DLW on a group basis, its use as a proxy measure of individual daily physical activity energy expenditure may be limited in older women and men” (p. 2095).

Validity - Indirect evidence

Twenty-five volunteers, 14 men (mean age 70.7 ± 5.5 years) and 11 women (mean age 68 ± 5.6 years), representing a healthy subset of the 222 older adults used to formulate the Yale Survey items, participated in a validity study (DiPietro et al. 1993). Validation criteria were maximal oxygen consumption estimated from a submaximal treadmill test, resting diastolic blood pressure, body mass index, percent body fat estimated from skinfold measurements, and physical activity assessed over 2.5 weekdays by a portable accelerometer (Caltrac). Energy expenditure (kcal/week) calculated from section 1 of the survey was negatively associated with resting diastolic blood pressure (r = -0.47, p = 0.01). No significant associations were reported between any of the criterion measures and energy expenditure or total activity time (hours/week) estimated from section 1 of the Yale Survey. The summary index calculated from section 2 (arbitrary units) was positively associated with estimated maximal oxygen consumption (r = 0.58, p = 0.004), and negatively associated with percent body fat (r = -0.43, p = 0.03). The vigorous activity index was associated with maximal oxygen consumption (r = 0.60, p = 0.003) and the sitting activity index (hours/day) was associated with resting diastolic blood pressure (r = 0.53, p = 0.01). No significant associations were noted between the summary index or any of the individual activity dimension indices (sections 3) and the criterion variables.

DiPietro et al. (1996) examined the association between physical activity, assessed by the Yale Physical Activity Survey, and cognitive function in a cross-sectional analysis of data on 1,189 adults, age 70 - 79 years, from the MacArthur Study of Successful Aging cohort. Total physical activity score showed a modest, but statistically significant bivariate correlation (r = .02, p < 0.001) with a total cognitive ability score. Significant bivariate associations (p < 0.01) were also noted between physical activity assessed by the Yale Survey and level of education, gender, self-rated health, and average peak expiratory flow rate. The results of multivariate analyses indicated
that physical activity had a significant association with the total cognitive ability score that was independent of gender, self-rated health, average peak expiratory flow rate, body mass index, number of social relationships, and visual contacts in the past month. However, the addition of education to the multivariate model substantially diminished the effect of physical activity.

Reliability

The test-retest reliability over a 2-week interval was assessed in 20 men (mean age 71.0 ± 6.8 years) and 56 women (mean age 71.1 ± 6.5 years) volunteers recruited from the 222 older individuals used to formulate the Yale survey (DiPietro et al. 1993). Correlations between the first and second administrations for total time (hours/week) and energy expenditure (kcal/week) estimated from responses to the activity checklist (section 1) were 0.57 (p = 0.0001) and 0.58 (p = 0.001), respectively. A higher correlation was noted for exercise and recreational items on the activity checklist compared with lower intensity activities such as housework and gardening (section 1). Test-retest correlations for the activity dimension indices (Section 2) were all statistically significant (p < 0.002) and ranged from 0.65 for the summary score (total units) to 0.42 for sitting (hours/day).

The Physical Activity Scale for the Elderly

The Physical Activity Scale for the Elderly (PASE), developed in a random sample of 277 community dwelling adults in Western Massachusetts, mean age 73 years, was designed specifically to assess physical activity in epidemiologic studies of persons age 65 years and over (Washburn et al., 1993). The PASE score combines information on leisure, household and occupational activity during the past 7-days. Participation in leisure activities including, walking outside the home, light, moderate and strenuous sport and recreation, and muscle strengthening are recorded as never, seldom (1-2 days/wk), sometimes (3-4 days/week) and often (5-7 days/week). Duration of participation in these activities is categorized as less than 1 hour, between 1-2 hours, 2-4 hours or more than 4 hours. Paid or unpaid work, other than work that involves mostly sitting activity, is recorded in total hours/week. Housework (light and heavy), lawn work/yard care, home repair, outdoor gardening and caring for others are recorded as yes/no. The frequency and duration of household activities is not requested. The total PASE score is computed by multiplying the amount of time spent in each activity (hours/week) or participation (yes/no) in an activity by empirically derived item weights and summing over all activities. The item weights were originally derived by regressing a component score developed from a 3-day physical activity monitor, 3-day physical activity diary and a global self-report of physical activity on responses to the PASE.

Validity - Direct Evidence

Schuit et al. (1997) compared PASE scores from a slightly modified version of the PASE with energy expenditure over a 2-week period, measured by doubly labeled water, in a sample of 10 men (mean age 70.6 ± 3.8 years) and 11 women (mean age 69.2 ± 4.8 years) living in Holland. They reported a significant correlation of the modified PASE score with a physical activity score estimated from the residuals of a regression analysis using total energy expenditure as the dependent and resting metabolic rate as the independent variable (r = 0.58, 95% CI = 0.50 - 0.81). These authors also reported higher PASE scores in women compared with men. Washburn and Ficker (1999) compared PASE scores with physical activity measured over 3 consecutive week days (Wednesday-Friday) by a portable accelerometer in 20 healthy adult volunteers (17 women, 3 men), age 67-80 years. PASE scores were significantly correlated (p < 0.05) with average 3-day accelerometer readings (r = 0.49) in the total sample and in those over age 70 years (r = 0.64).

Validity - Indirect Evidence

In the sample of 222 community dwelling older individuals used to develop the PASE, Washburn et al. (1993) reported significant associations (p < 0.05) between PASE scores and grip strength (r = 0.37), static balance (r = 0.33), leg strength (r = 0.25), resting heart rate (r = -0.13), age (r = -0.13), and sickness impact profile score (r = -0.42). The mean PASE scores in this sample were higher in men than in women, and as expected, were higher during the warmer summer months compared with the colder months of winter.

Washburn et al. (1999) also provided indirect evidence for the validity of the PASE in a sample of sedentary adults (56 men, 134 women, mean age 66.5 ± 5.3 years) who volunteered to participate in a randomized controlled trial on the effect of aerobic conditioning on psychological function. Construct validity was established by correlating PASE scores with physiologic and performance characteristics: peak oxygen uptake, resting heart rate and blood pressure, percent body fat, and balance. PASE scores were significantly associated (p < 0.05) with peak oxygen uptake (r = 0.20), systolic blood pressure (r = -0.18) and balance score (r = 0.20). No significant associations of PASE score and diastolic blood pressure, resting heart rate or percent body fat were noted. In addition, mean PASE scores were higher in men than in women (men = 145.8 ± 78.0; women = 123.9 ± 66.3, p < 0.05), and in those age 55-64 years compared with those age 65 years and over (55-64 = 144.2 ± 75.8; 65 and
over \( = 118.9 \pm 63.9, p < .05 \). PASE scores were also significantly higher \( (p < .05) \) in those who did not report a chronic health condition (cardiovascular disease, hypertension, cancer or recent surgery).

Additional indirect evidence for the validity of the PASE comes from a study of 240 women and 231 men, mean age 71.7 \( \pm 4.9 \) years who participated in a prospective study of chronic knee pain (Martin et al., 1999). In this sample, PASE scores were significantly associated \( (p < .001) \) with age \( (r = -0.21) \), total distance traveled on a 6-minute walk test \( (r = 0.35) \), knee strength measured on an isokinetic dynamometer \( (r = 0.41) \), and perceived difficulty with physical function \( (r = 0.35, \text{note: higher scores equal less difficulty}) \). Men in this sample had significantly higher \( (p < 0.001) \) PASE scores compared with women \( (men = 153 + 74.4, women = 109.8 + 60.6) \).

### Reliability

Washburn et al. (1993) assessed the test-retest reliability of both a telephone interview and self-administered version of the PASE in a random sample of 277 community dwelling men and women, mean age 73 years, over a 3 to 7 week interval. The correlation between tests 1 and 2 were \( r = 0.84 \) and \( r = 0.68 \) for the self and interview administered versions, respectively.

### Comment and recommendations

It is essential that valid and reliable physical activity surveys, developed and evaluated specifically for use with the elderly, are used when assessing the association between physical activity and health and functional ability in samples of older individuals. Currently only four published physical activity surveys specific for older individuals are available. The methodologic issues relative to establishing the reliability and validity of physical activity questionnaires are well documented (Montoye, Kemper, Saris, & Washburn, 1995). For example, when evaluating instrument reliability it is difficult to determine if poor agreement between repeated test administrations is due to poor recall or to actual changes in physical activity behavior. In addition, the length of time between test administrations can influence reliability. The evaluation of questionnaire validity is also problematic due to the lack of an acceptable criterion measure of physical activity to which the questionnaire results can be compared. Physical activity questionnaires are generally validated by using either direct criterion measures, such as physical activity assessed by a diary, doubly labeled water, or motion sensors or indirect criterion measures such as maximal aerobic capacity, body composition, muscular strength, blood pressure, lipids etc. Several reports have suggested that the validation of physical activity questionnaires for older adults using indirect validation criteria may be inappropriate given that the limited number of older individuals who participate in higher intensity conditioning activities, the type of activity more likely to be associated with most indirect criterion measures (Bernstein et al., 1998; Tager, Hollenberg & Satariano, 1998; Yusuf et al., 1996).

As evident in this review, there is limited information on the reliability and validity of physical activity questionnaires for older adults, however the available data suggests that the reliability and validity of these questionnaires is similar to that reported for several of the widely used age-neutral physical activity questionnaires (Jacobs, Ainsworth, Hartman, & Leon, 1993; Montoye et al., 1995; Pereira et al., 1997). The test-retest reliability of the 4 physical activity surveys for older adults has been evaluated over time intervals ranging from 14 days to 4 months and in samples ranging in size from 21 to 277 individuals. The reported reliability coefficients range from \( r = 0.68 \) to \( r = 0.93 \). There is limited information on the validity of the activity surveys for older adults that have used direct validation criteria. The total sample size for all validity studies that used direct criterion measures over all 4 surveys included only 89 women and 80 men. Correlations in the range of \( r = 0.42 \) to 0.75 were reported between activity assessed by surveys for the elderly and doubly labeled water, dietary intake, motion sensors, and 24-hour physical activity recall. The result of both the reliability and validity studies should be interpreted cautiously as they have been conducted in small volunteer samples of generally healthy, well educated, white individuals. Both the reliability and validity of physical activity surveys for older adults should be further evaluated in more generalizable, randomly selected samples of varied racial and ethnic backgrounds. It is suggested that, when possible, direct criterion measures such as contemporaneous activity diaries, motion sensors, or doubly labeled water be used in future validity studies.

The assessment of physical activity in older individuals is especially difficult due to the fact that most of the physical activity engaged in this age group is of light to moderate intensity (Bernstein et al., 1998; Washburn et al., 1990), the type of activity that has been shown to be the most difficult to recall (Baranowski, 1987; Sallis et al., 1985; Washburn et al., 1990). In addition, the accuracy of recall of physical activity has been reported to vary by age, gender, body size, level of education, and household income (Cumming & Klineberg, 1994; Falkner et al., 1994; Klesges et al., 1990; Washburn et al., 1990). Further studies are warranted to evaluate factors associated with physical activity recall in older individuals. This information would be useful in guiding the refinement of currently available survey items or for the development of new items that would hopefully elicit more precise physical activity information. In addition, if factors associated with either under or over reporting of physical...
activity are identified, it may be possible to develop techniques to adjust physical activity scores to reduce the effect of reporting bias. Although not well studied, it appears that a personal or telephone interview is the preferred mode of administration when using questionnaires to assess physical activity in older adults. Reports by Washburn et al. (1993) and Martin et al. (1999), using the PASE suggest that older individuals tend to over report physical activity when the survey was self-administered. Additional work to determine the effect of administration mode on the validity of physical activity measures in the elderly is warranted.

References


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