PASE
Physical Activity Scale for the Elderly

Administration and Scoring Instruction Manual

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INTRODUCTION

The Physical Activity Scale for the Elderly (PASE) is an easily administered and scored instrument that measures the level of physical activity in individuals aged 65 years and older. The development of this instrument was supported by a Small Business Innovation Research grant from the National Institute on Aging. The instrument is comprised of self-reported occupational, household and leisure activities items over a one-week period and may be administered by telephone, mail or in-person. The PASE scoring algorithm was derived from physical activity measured by movement counts from an electronic physical activity monitor, activity diaries, and self-assessed activity levels in a general population of non-institutionalized older persons. The PASE can be used to measure physical activity levels in epidemiologic surveys of older people as well as to assess the effectiveness of exercise interventions.

ADMINISTRATION INSTRUCTIONS

The PASE may be administered by interview or completed by elderly respondents. The instrument is printed in a large type face to make it easy for older persons to read. Self-administered or interviewer-administered versions of the instrument can be completed in 5 to 15 minutes.

The first page of the questionnaire provides general instructions and shows an example of a completed item. Respondents should be encouraged to answer each item by circling the correct response. All items refer to activities performed in the previous seven days. “Never” and “No” responses should always be marked to indicate any activities the respondent did not perform during that period.

The leisure activity items require respondents to first report the number of days per week the activity was performed and then the number of hours per day. Space is also provided for respondents to record the types of activities in which they engaged. These reports should be reviewed before computing PASE scores to ensure that specific sports and recreational activities have been recorded in the appropriate categories.

SCORING INSTRUCTIONS

PASE scores are calculated from weights and frequency values for each of 12 types of activity. Responses to the first question about sitting activities are not scored. The PASE scoring form is shown in Table 1.

TABLE 1

PASE SCORING FORM

PASE Item	Type of Activity	Activity Weight	Activity Frequency	Weight times Frequency
2.	Walk outside home	20	a.	
3.	Light sport / recreational activities	21	a.	
4.	Moderate sport / recreational activities	23	a.	
5.	Strenuous sport / recreational activities	23	a.	
6.	Muscle strength / endurance exercises	30	a.	
7.	Light housework	25	b.	
8.	Heavy housework or chores	25	b.	
9a.	Home repairs	30	b.	
9b.	Lawn work or yard care	36	b.	
9c.	Outdoor gardening	20	b.	
9d.	Caring for another person	35	b.	
10.	Work for pay or as volunteer	21	c.	
			PASE SCORE:	

<u>Activity Frequency Values:</u>

a. Use hours per day conversion table below
b. 1 = activity reported in past week, 0 = activity not reported
c. Divide work hours reported in Item 10.1 by seven; if no work hours or if job involves mainly sitting with slight arm movements (Item 10.2 = 1), then activity frequency = 0.

ACTIVITY TIME TO HOURS PER DAY CONVERSION TABLE

Days of Activity	Hours Per Day of Activity	Hours Per Day
0. Never		0
1. Seldom	1. Less than 1 hour	.11
	2. 1-2 hours	.32
	3. 2-4 hours	.64
	4. More than 4 hours	1.07
2. Sometimes	1. Less than 1 hour	.25
	2. 1-2 hours	.75
	3. 2-4 hours	1.50
	4. More than 4 hours	2.50
3. Often	1. Less than 1 hour	.43
	2. 1-2 hours	1.29
	3. 2-4 hours	2.57
	4. More than 4 hours	4.29

To Compute a PASE Score:

1. Review the leisure time activities recorded by respondents or interviewers to ensure that sports and recreational activities are correctly classified as light, moderate, or strenuous. Appendix A shows the appropriate activities for each of these categories; a detailed description of more complex coding situations may be found in Appendix B. Household activities should <u>not</u> be recorded as sports or recreation.

2. Determine the frequency value (hours per day in the one-week reporting period) for each activity. For the walking, exercise, and sports/recreation items, frequency values are derived from the number of days and hours per day of activity, as shown in the conversion table at the bottom of the scoring form. Household activity values are "1" if an activity was reported in the past seven days and "0" if it was not. The frequency value for paid of volunteer work is the number of hours worked in the past week divided by seven. The activity frequency is zero for jobs that involve mainly sitting with slight arm movements.

3. Multiply the activity weight by the activity frequency for each item.

4. Sum the activity weight by the activity frequency products for all 12 items. We recommend that these totals be rounded to the nearest integer. PASE scores may range from zero to 400 or more.

An example of these scoring procedures is presented in Table 2 for a respondent who had a part-time job, walked outdoors, and engaged in light sports, activity, light housework, and lawn work during the previous week. The PASE score for this respondent is 149.5, which may be rounded to 150.

PASE SCORING EXAMPLE

Respondent reports:

- Walking outside home (sometimes; 1-2 hours per day)
- light sports (golf with a cart; seldom; 2-4 hours per day)
- work involving sitting or standing with some walking (20 hours per week)
- light housework and lawn work in past seven days

PASE Item	Type of Activity	Activity Weight	Activity Frequency	Weight times Frequency
2.	Walk outside home	20	.75	15.0
3.	Light sport / recreational activities	21	.64	13.4
4.	Moderate sport / recreational activities	23	0	0
5.	Strenuous sport / recreational activities	23	0	0
6.	Muscle strength / endurance exercises	30	0	0
7.	Light housework	25	1	25.0
8.	Heavy housework or chores	25	0	0
9a.	Home repairs	30	0	0
9b.	Lawn work or yard care	36	1	36.0
9c.	Outdoor gardening	20	0	0
9d.	Caring for another person	35	0	0
10.	Work for pay or as volunteer	21	2.86	60.1
			PASE SCORE:	149.5

The computer code to calculate PASE scores is reproduced in Appendix C.

VALIDITY AND RELIABILITY OF THE PASE

The validity and reliability of the PASE were established in a random sample (N = 222) of individuals aged 65-100 years. PASE scores were validated through comparisons with physiologic and health status data measured in the home. In this sample, PASE scores were significantly correlated with balance, grip strength, leg strength, self-assessed health status, and Sickness Impact Profile scores. PASE scores also exhibited temperature-related seasonal variation. The reliability of PASE scores was evaluated by stability over repeated administrations three to seven weeks apart. The test-retest reliability coefficient was .75 (95% CI = .69-.80). Reliability for mail administration (r = .84) was higher than for telephone administration (r = .68). A detailed description of the development of the PASE as well as reliability and validity results may be found in Appendix D.

PRELIMINARY NORMS

Preliminary norms for PASE were established in a general population of older adults. In this sample scores ranged from 0 to 361. The mean score was 102.9 (standard deviation = 64.1); the median was 90. Mean scores (and standard deviations) by age and gender were as follows:

	AGE GROUP		
	65-69 yrs.	70-75 yrs.	76-100 yrs.
MEN	144.3 ± 58.6	102.4 ± 53.7	101.8 ± 45.7
WOMEN	112.7 ± 64.2	89.1 ± 55.5	62.3 ± 50.7

APPENDIX A:
ACTIVITY CATEGORIES

Light Sport and Recreation

archery
badminton
billiards
boating (canoeing, rowing sailing)
bocci
bowling
catch
croquet
darts
fishing
frisbee
golf with a power cart
horseshoes
musical program
riflery
shuffleboard
swimming: no laps
table tennis

Moderate Sport and Recreation

barn chores
dancing (ballroom, ballet, disco)
fencing
football
golf without a cart
horseback riding
scuba diving
skating (ice, roller)
sledding
snorkeling
softball / baseball / cricket
surfing
tennis (doubles)
trampoline
volleyball

Light Housework

drying dishes
dusting
hanging up laundry
ironing
laundry
meal preparation
washing dishes

Strenuous Sport and Recreation

aerobic dance or water aerobics
backpacking
baseball
bicycling / exercise bike
board sailing
handball / paddleball
racquetball
hiking
hockey (ice or field)
jogging
lacrosse
mountain climbing, running
rope skipping
rowing machine
rowing / canoeing for competition
skiing (cross country, downhill, water)
snow shoeing
soccer
stair climbing
squash
swimming laps
tennis (singles)

Muscle Strength and Endurance

calisthenic
hand weights
physical therapy with weights
push-ups
sit-ups
weight-lifting

Heavy Housework

carrying wood
mopping floors
moving furniture
scrubbing floors
sweeping
vacuuming
washing walls
washing windows
washing cars

APPENDIX B:
PASE CODING EXAMPLES

The following examples are provided as guidelines regarding the administration and coding of the PASE.

QUESTION 1

Example: Respondent watches the news every day for one hour. On Tuesday, the respondent plays bingo for three hours. Also, the respondent attends meetings twice a week. One meeting lasts one hour, and the other meeting lasts two hours.

Since the respondent watches TV every day, the interviewer would code sitting activities as often (5-7 days). During the week, the respondent reported 13 hours of sitting (7 hours of TV watching, 3 hours of Bingo, and 3 hours of meeting). Dividing the total hours/week (13) by the days engaged in sitting activities per week (7) results in hours per day engaged in sitting activities (1.9 hours; 1 but less than 2 hours).

Visiting with others, sewing, paperwork, playing musical instruments, playing cards, and/or bingo are considered sitting activities.

QUESTION 2

Example: The respondent walks 30 minutes to 1.5 hours per day.

The average time spent walking was 1 hour. One but less than 2 hours per day is coded for walking.

Example: Three times a week, the respondent walks 3-4 times a day for 15 minutes.

Coding. Throughout the PASE, the number of days rather than the number of occasions is coded. Therefore, the respondent walked sometimes (3-4 days). The respondent averaged 52.5 minutes of walking (3.5 times x 15 minutes) on those days, which is coded as less than one hour of walking outside the home or yard.

Any leisure time, household or work related activity that involves walking is coded entirely under the appropriate activity category (light, moderate, or strenuous sport and recreation, muscle strength and endurance, or work-related). Hence, walking as part of golf would be coded only as moderate sport and recreation (Question 4) and not as walking (Question 2).

Walking within the respondent's yard is excluded from the question. Treadmill walking should be included under Question 2.

QUESTION 3

Example: The respondent plays golf 4 days per week for 4 hours/day. Three days a week, the golfer uses a power cart. One day a week the golfer walks the course either pulling a cart, carrying the clubs, or the caddy carries the clubs.

Only golf with the power cart would be coded under light sport and recreation. Specifically, the respondent golfed with a cart sometimes (3-4 days/week) for 2-4 hours/day. Golfing without a cart would be marked under moderate sport and recreation as seldom (1-2 days) for 2-4 hours per day. Putting or hitting golf balls at a driving range are coded for light sport and recreation.

Stretching is not coded under and activity category in the PASE.

QUESTION 4

Gardening and lawn work are not coded under leisure time activities. Gardening and lawn work are considered household activities. Question 9B addresses lawn work, and Question 9C pertains to gardening.

QUESTION 5

Example: The respondent swims laps but considers the activity light rather than strenuous sport and recreation.

Swimming laps is coded a strenuous sport and recreational activity regardless of the respondent's assessment of the activity's intensity. Leisure time activities are preassigned activity categories as listed in Appendix A.

Example: The respondent participates in a one-hour aerobics class, 3 days per week. The class consists of 20 minutes of stretching, 20 minutes of hand weights of calisthenics, and 20 minutes of aerobic dance.

Coding. The aerobics class would be coded under two categories. The 20 minutes of aerobic dance would be coded under strenuous activities, and the 20 minutes of calisthenics would be coded under muscle strength and endurance. The 20 minutes of stretching would not be coded under any activity category. Under strenuous activities, the interviewer would list aerobics and circle less than 1 hour/day for 3-4 days per week. Likewise, aerobics would be listed under muscle strength and endurance for less than 1 hour/day for 3-4 days per week.
Climbing stairs as part of an exercise regimen is coded under strenuous sport and recreation. However, stair climbing as part of daily activities is not coded in the PASE.

QUESTION 6

Strenuous work activity, such as moving furniture, is not included in this question. Only activities that are done specifically to increase muscular strength and endurance are used in Question 6.

QUESTION 7

Drying dishes, clothes washing, ironing, hanging up laundry, taking out the garbage, and preparing meals are considered light housework. (See Appendix A.)

QUESTION 8

See Appendix A for applicable activities.

QUESTION 9A

Home repair includes home improvement and maintenance projects such as painting, plumbing, and carpentry.

QUESTION 9B

Snow removal (sweeping snow, shoveling snow or using a snowblower) is considered to be lawn work or yard care. Lawn mowing is counted as lawn work regardless of the type of mower (riding, power, or push) used.

Stacking wood as a household chore is considered to be heavy housework (Question 8); chopping wood outdoors should be coded under Question 9B.

QUESTION 9C

Example: Respondent does outdoor gardening in season. In February, the respondent has not started the garden yet.

Outdoor gardening is coded "no". Only activities performed during the past seven days are coded.

QUESTION 9D

Dependency is defined as a person requiring assistance with activities of daily living (food preparation, personal hygiene, household cleaning). Division of labor within a household (i.e. meal preparation, laundry, yardwork) is not considered dependency.

Babysitting is included in Question 9D. Babysitting is not included in Question 10 as a work-related activity.

Pet care is not considered part of Question 9D.

QUESTION 10

Only work performed during the past 7 days is coded.

Example: The respondent works half the time sitting or standing with some walking, and the other half of the time walking, with some handling of materials.

Higher rather than lower activity levels are coded if the respondent indicates two categories of physical activity required on the job or volunteer work.

Respondents should be encouraged to give their best estimate of the number of hours they worked during the previous seven days. However, if a range of hours is reported (e.g. 15-20 hours), use the midpoint of the range as an estimate.

APPENDIX C:
COMPUTER CODE FOR PASE SCORING

The following code may be used to calculate PASE scores by computer. Questionnaire items are designated by “Q” followed by the PASE item number, e.g., Q9C refers to questionnaire item 9C (outdoor gardening).

```
RECODE Q2, Q3, Q4, Q5, Q6 (0=0)(1 =1.5)(2=3.5)(3=6)(ELSE = -1)
RECODE Q2A, Q3B, Q4B, Q5B, Q6B (1=.5)(2=1.5)(3=3)(4=5)
COMPUTE Q2 = Q2 * Q2A/7.
COMPUTE Q3 = Q3 * Q3B/7.
COMPUTE Q4 = Q4 * Q4B/7.
COMPUTE Q5 = Q5 * Q5B/7.
COMPUTE Q6 = Q6 * Q6B/7.
RECODE Q7, Q8, Q9A, Q9B, Q9C, Q9D (1=0)(2=1)(ELSE = -1)
RECODE Q10 (1=0)
IF (Q10B = 1) Q10 = 0.
IF (Q10B ≥ 2) Q10 = Q10A/7.
COMPUTE PASE = 20*Q2 + 21 *Q3 + 23*(Q4 + Q5) + 30*Q6 +
25*(Q7 + Q8) + 30*Q9A + 36*Q9B + 20*Q9C + 35*Q9D + 21*Q10.

MISSING VALUE ALL (-1).
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APPENDIX D:

PASE DEVELOPMENT, RELIABILITY AND VALIDITY ANALYSES

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THE PHYSICAL ACTIVITY SCALE FOR THE ELDERLY (PASE): DEVELOPMENT AND EVALUATION

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Abstract—A Physical Activity Scale for the Elderly (PASE) was evaluated in a sample of community-dwelling, older adults. Respondents were randomly assigned to complete the PASE by mail or telephone before or after a home visit assessment. Item weights for the PASE were derived by regressing a physical activity principal component score on responses to the PASE. The component score was based on 3-day motion sensor counts, a 3-day physical activity diary and a global activity self-assessment. Test–retest reliability, assessed over a 3–7 week interval, was 0.75 (95% CI = 0.69–0.80). Reliability for mail administration ($r = 0.84$) was higher than for telephone administration ($r = 0.68$). Construct validity was established by correlating PASE scores with health status and physiologic measures. As hypothesized, PASE scores were positively associated with grip strength ($r = 0.37$), static balance ($r = +0.33$), leg strength ($r = 0.25$) and negatively correlated with resting heart rate ($r = -0.13$), age ($r = -0.34$) and perceived health status ($r = -0.34$); and overall Sickness Impact Profile score ($r = -0.42$). The PASE is a brief, easily scored, reliable and valid instrument for the assessment of physical activity in epidemiologic studies of older people.

Elderly   Physical activity assessment questionnaire

INTRODUCTION

Physical activity is a modifiable behavioral risk factor related to the maintenance of health and effective function in older people [1]. Evidence from the Alameda County Study showed that, among the elderly, participation in leisure time physical activity was associated with a decreased 17-year follow-up mortality risk that was independent of age, socioeconomic status, health status, smoking, relative weight and alcohol consumption [2]. Mor [3] reported that those individuals 70–74 years of age from the Supplement on Aging cohort who did not participate in regular exercise or could not walk a mile without resting were more likely to suffer a decline in functional status over a 2-year period after controlling for medical conditions and demographic factors. Maintaining an active lifestyle in later years has been associated with a decreased risk for falls and fractures [4, 5] as well as preventing age-associated declines in bone density [6, 7], cardiovascular fitness [8] and muscular strength [9, 10]. However, limited information is available regarding the specific types and amount of physical activity necessary for maximum health benefits in older people.

Research on physical activity and health in older people has been hampered by the lack of physical activity assessment methods designed for older people and suitable for use in epidemiologic research. Techniques such as movement counters [11, 12], heart rate monitoring [13] or activity diaries [14, 15] are available but all suffer important shortcomings. Cost is the major problem. Movement counters, monitors and diaries are expensive in either equipment requirements (motion sensor, heart rate monitoring) or time and effort required by both respondent and investigators (diaries). Logistical problems and subject burden are also concerns. Pick-up and delivery of equipment, and respondent co-operation in detailed data recording limit their use to studies of small, highly selective samples.

A physical activity questionnaire is a practical and widely used approach for physical activity assessment in epidemiologic investigations [16]. Activity questionnaires have been used in studies relating physical activity to fall and fracture risk, balance and gait characteristics, bone density, and coronary heart disease in older people [4, 5, 17–19]. Unfortunately, activity questionnaires currently in use with older people have been designed for younger populations [20–22]. The Centers for Disease Control Behavioral Risk Factor Surveillance System, for example, contains a physical activity questionnaire designed to monitor the physical activity habits of the U.S. population. It uses the same questions and response format for respondents age 18 to over 70 years [23]. Results from recent work strongly indicates that physical activity questionnaires designed for use with younger people (i.e. age-neutral) are inaccurate when used with older people [24]. In comparing responses from an age-neutral questionnaire with physical activity estimates from a 3-day diary, 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/day) but was substantial (2 hours 20 minutes/day) for less strenuous physical activity categories (i.e. walking, household chores, light sport and recreation). Questionnaires designed for younger people suffer from other shortcomings when used with older people. The time frame over which activity is assessed can be too long (months, years), domains of activity most likely engaged in by older people are not included or emphasized (walking, light-moderate housework, outdoor work, etc.), and an open-ended response format (for example, asking how many minutes per week one engages in a specific activity) can be difficult for older people to report accurately.

An accurate physical activity instrument designed specifically for older people would fill an important need in epidemiologic research. This project was undertaken to design and evaluate an age-specific physical activity questionnaire that would overcome the problems inherent in existing methods.

METHODS

Instrument development

We reviewed over 40 publications from the scientific literature on questionnaire assessment of physical activity. From these papers we prepared a list of physical activity categories and specific items within each category that were most relevant for older people. This list was distributed to two consultants, authorities in the area of physical activity assessment (Dr R. E. LaPorte and Dr S. N. Blair), who reviewed the material and met with project investigators. Occupational, household and leisure time activities were included in the initial questionnaire. In addition, the initial questionnaire included items on living situation, sleep, and restricted activity days as potential discriminators of activity among older people whose activity levels were, in general, quite low. Investigators and staff developed a draft questionnaire which formed the first version of PASE (*P*hysical *A*ctivity *S*cale for the *E*lderly). This version of PASE was pilot tested in a small sample of older persons living in Boston and Amherst, MA (age 65–74, $n = 12$; age 75–84, $n = 15$; age 85+, $n = 9$). Trained interviewers conducted interviews to assess the appropriateness of the items, comprehensibility, and completeness. Open-ended evaluation questions were asked to solicit feedback on all aspects of the PASE. Results were used to prepare a final version of the instrument which was reviewed by three age-eligible volunteers. The validity and reliability of this instrument was assessed in the field in the second phase of this study.

Sampling procedures

The target area for the study consisted of 23 western Massachusetts cities and towns within a 25-mile radius and the same telephone area code as Amherst, MA. This area contains two cities (Springfield and Chicopee) that had populations exceeding 50,000 residents in 1980 as well as suburban and rural communities of varying sizes. All persons aged 65 years or older living in their own households without serious mental or physical impairments were eligible for the study. The size of the sample was based on a statistical power analysis of the number of cases needed to detect validation correlations exceeding 0.2 and to obtain test–retest coefficients with a 95% confidence interval of 0.06.

A two-stage procedure was employed to select study respondents. Towns were stratified by median 1980 household income (less than or more than $20,000). Half of the towns in each stratum were randomly selected. Due to its size, the city of Springfield was a separate self-representing stratum. In the second stage, 1989 Massachusetts street lists (a state-mandated census of persons of voting age) in the selected towns were used to identify eligible older adults. Persons born in 1924 or earlier were systematically sampled from these lists at a rate proportional to the total number of adults aged 65 or older in each town. Unequal selection probabilities in the first stage were offset by sampling eligible adults in Springfield at half the rate used in the other 11 towns to produce a self-weighting sample of individuals in the target area.

Survey protocol

Each adult in the sample was randomly assigned to one of four groups based on the type of PASE administration (telephone or mail) and the timing of data collection (home visits conducted before or after the PASE questionnaire). Half of the sample received home visits first and then completed either the mail or telephone questionnaire; the other half were administered the physical activity questionnaire prior to the home visit. Using the addresses appearing in the street lists, each eligible person was sent an introductory letter explaining the purposes of the study. Subjects were then contacted by telephone to schedule a home visit. A minimum of 10 calls was made to each household to locate respondents. Persons who had died, lived in nursing homes, had serious cognitive impairments, or could not speak or read English were not eligible. Persons assigned to groups in which interviews were to be conducted prior to visits were asked to complete the PASE even if they refused to permit a home visit. Baseline respondents were recontacted 3 weeks later and asked to complete a second questionnaire to assess test–retest reliability.

In-home protocol

All home visits were conducted by trained field technicians between January 1990 and February 1991. Written informed consent was obtained from all respondents. Home visit measures were collected in the following order. Blood pressure (BP) was measured three times using a standard mercury sphygmomanometer with the respondent seated for at least 5 minutes prior to measurement with legs uncrossed at the time of readings. The last BP reading was used in the analysis. Height and weight were measured using standardized procedures patterned after the Pawtucket Heart Study protocol [25], with respondents in stockinged feet and indoor clothing. Height was rounded up to the nearest eighth of an inch and weight was rounded down to the nearest pound.

Grip strength of the dominant hand was assessed with respondents in a standing position. Static balance of the dominant leg (same side as dominant arm) was assessed by the one leg stance test with eyes closed [26]. Respondents in stockinged feet were instructed to close their eyes and raise their non-dominant foot from the floor. Balance time (to the nearest 0.1 second) was assessed with a stopwatch from the time the non-dominant foot left the floor until either the dominant foot was displaced, the non-dominant leg touched the dominant leg, or the non-dominant leg touched the floor.

Isometric knee extensor strength at 60° knee flexion was measured with a portable Isokinetic, Inc. (Grand Rapids, MI) knee unit [27]. This unit consists of a padded seat and a bracket that holds a spring gauge and a cuff assembly for attachment to the respondent's leg directly above the lateral malleolus. Respondents sat on the padded seat with their popliteal fossa placed against the front of the padded surface. For stabilization the thigh of the leg being tested was strapped to the seat. Respondents sat with a straight back with hands grasping the side of the padded seat and were asked to exert maximal force against the ankle cuff. Testing of the dominant leg always preceded testing of the non-dominant leg.

The results of three separate trials were recorded for grip strength, static balance and leg strength. The mean of these three trials was used in statistical analyses.

Health status was assessed by the Sickness Impact Profile (SIP), a measure of the impact of disease on daily activities and behaviors in 12 functional areas [28, 29]. Demographic characteristics were reported using standard items from national surveys. At the conclusion of the home visit, field technicians explained the use of the movement counter and an activity diary. Respondents were asked to wear the movement counter and record their activity patterns for the next 3 days.

Activity monitor. Physical activity was monitored using a Caltrac Personal Activity Computer (Hemokinetics Inc., Madison, WI). Details regarding development and construction of the Caltrac as well as the validity of the Caltrac for older people are available elsewhere [30, 31]. The Caltrac is a small, lightweight (9.5 cm × 7.0 cm × 1.25 cm; weight = 75 g) device designed to measure acceleration via a piezo-electric bender element. A numerical score (kcal) is provided by a liquid crystal display. The total kcal score is a function of the respondent's basal metabolic rate calculated by a computer chip programmed with the respondents age, height, weight and gender, plus additional caloric expenditure resulting from body movement. Since our purpose was to use the Caltrac only as a movement counter, we by-passed the metabolic program as instructed by the manufacturer and used daily Caltrac counts in the analysis. Respondents were instructed to wear the Caltrac on a belt over the dominant hip and record Caltrac readings and the time of day both in the morning and on retiring for the evening on a chart attached to an activity diary.

Activity diary. For each waking hour during the 3 day observation period, respondents were asked to maintain an activity diary of the amount of time spent in eight activity categories: lying down, sitting, standing, standing light work (dishes, dusting), standing moderate/heavy work (carpentry, gardening, lifting), walking, light sport and recreation (golf, bowling, ball games), and heavy sport and recreation (running, cycling). Daily energy expenditures (METS) were calculated by multiplying the amount of time spent in an activity by a MET value reflecting the intensity of that activity. MET values ranged from 1.0 for lying down to 6.0 for heavy sport and recreation [32].

After the third day, respondents also completed a 5-point scale assessing their level of physical activity. Scale values ranged from 1 = not active at all to 5 = extremely active.

Caltracs, diaries and self-report scale scores were returned to the investigators by mail. Daily averages for the Caltrac counts and diary METS were determined for the 3-day monitoring period. Data were not included in the averages if the reporting periods for the diary and Caltrac differed by more than 2 hours on a given day.

PASE scoring

To devise a set of weights for the PASE items that would provide the best overall estimate of an older person's physical activity level, a criterion measure of physical activity was created from a principal components analysis of Caltrac counts, METS totals from the activity diary, and the global self-report of physical activity. This approach, which is rooted in classical test theory [33] and confirmatory factor analysis [34], treats these three measures as fallible indicators of an unobserved physical activity construct. A principal component score for each subject was computed from the respective item loadings. These component scores, which represent our most refined estimate of the underlying physical activity construct, were then regressed on responses to the questionnaire to derive the optimal item weights for the PASE. Total PASE scores were computed by multiplying the amount of time spent in each activity (hours per day over a 7-day period) by the respective weights and summing over all activities.

Validation and reliability assessment

The stability of the PASE over time was assessed by the test–retest reliability correlation between baseline scores and follow-up scores reported 3–7 weeks later. To validate PASE scores, Pearson correlations were computed between these scores and measurements taken during home visits. Validation measures included physiologic characteristics known to be affected by activity levels (heart rate, body mass index, balance, grip and leg strength) [9, 10, 35–37] as well as aspects of health status that influence the ability to perform physical activities (total SIP score, self-assessed health status, and selected acute and chronic health conditions). Correlations with the validation measures were also computed for six respondent subgroups (based on mode of questionnaire administration, gender and age) to determine the consistency of these associations. In addition, we examined seasonal trends and respondent characteristics associated with PASE scores.

RESULTS

Response rates

Dispositions for the 1288 names sampled from the street lists are shown in Table 1. Two hundred twenty-four persons (19.8%) were ineligible for the study. Contact was not made with another 159 whose eligibility status could not be determined. Of those known to be eligible, 36.0% consented to a home visit and to complete the PASE. An additional 15.5% completed the PASE but refused a home visit. Table 2 compares the background characteristics of participants with non-participants. Non-participants were on average 2 years older than

Table 1. Disposition of street list names

Number of Cases	Disposition
159	No contact (moved, telephone disconnected, unlisted telephone number, no answer)
224	Ineligible (deceased, nursing home resident, mental/ physical impairment, younger than 65 years)
136	Refused telephone screener
251	Refused home visit, not asked to complete PASE
122	Refused home visit, and failed to complete PASE
119	Refused home visit, but completed PASE
277	Completed home visit and PASE
1288	Total names sampled from street lists

participants. Women were more likely than men to refuse a home visit. However, those who completed the telephone screener but refused to participate in all other aspects of the study were similar to participants with respect to perceived health, physical activity levels and perceived worry about their health.

Table 2. Background characteristics of participants and non-participants

		Participants	
Characteristics	Non-participants ($n = 668$)[a]	Home visit and PASE ($n = 277$)	PASE only ($n = 119$)
Age (yr)	75.0**	73.0	73.4
Percent female	61.7*	57.0	71.4
Percent living with spouse	40.9	48.7	40.3
Town income (median dollars in thousands)	18.9	18.9	18.5
Percent employed	17.2	17.7	18.8
Perceived health (1 = excellent to 5 = poor)	2.89[b]	2.73	2.86
Activity level (1 = very high to 5 = very low)	2.98[b]	2.89	2.98
Worry about health (1 = not at all to 4 = most of the time)	2.32[b]	2.26	2.34

[a]Includes no contact cases, screener refusals, and those who failed to complete a PASE.
[b]$n = 378$ non-participants who refused home visit and PASE but completed telephone screening.
*$p < 0.05$; **$p < 0.01$.

PASE score descriptive statistics

Figure 1 shows the results of the principal components analysis for the 193 subjects with complete data for the Caltrac, activity diary and global self-report item. The inter-item correlations among the three physical activity measures were moderately high and in the expected direction. The three measures had similar factor loadings on a single underlying component (eigenvalue = 1.87). The internal consistency of these items as measured by Cronbach's alpha was 0.69. The resulting component scores (mean = 0, standard deviation = 1) ranged from −2.44 to 3.54 with higher scores indicating greater physical activity.

Weights for individual activities were estimated by regressing component scores on the complete set of items in the original version of the PASE. Twelve types of activity accounted for 41.4% of the variation in component scores. Seven low expenditure activities (sleeping, napping, quiet activities, flexibility exercises, stair climbing, shopping or errands, and jobs involving sitting with slight arm movements) that were not significantly associated with

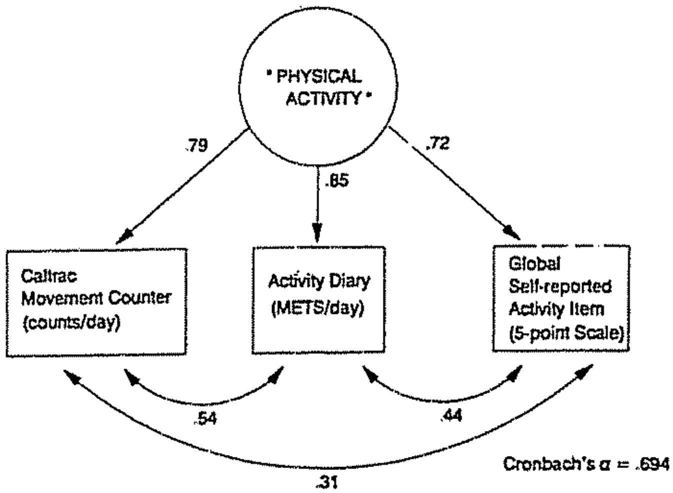

Fig. 1. Relationships between physical activity component and indicators of physical activity ($n = 193$). Curved arrows signify zero-order correlations; straight arrows indicate component loadings.

Table 3. PASE item weights and contributions to total score ($n = 314$)

PASE activity	Sample mean	PASE weight	Contribution to total PASE score
Muscle strength/ endurance	0.05 hr/day	30	1.5
Strenuous sports	0.07 hr/day	23	1.6
Moderate sports	0.11 hr/day	23	2.5
Light sports	0.09 hr/day	21	1.9
Job involving standing or walking	0.53 hr/day	21	11.1
Walking	0.65 hr/day	20	13.0
Lawn work or yard care	45.6%*	36	16.4
Caring for another person	24.2%*	35	8.5
Home repairs	22.0%*	30	6.6
Heavy housework	47.4%*	25	11.8
Light housework	89.5%*	25	22.4
Outdoor-gardening	26.8%*	20	5.4
			102.7

*Percentage of sample engaging in that activity during week.

activity levels were eliminated from the final version of the instrument. Activity weights in general did not differ significantly by mode of questionnaire administration (mail vs telephone), timing of administration (i.e. before or after home visits), age group or gender.

Table 3 displays the contribution of each questionnaire item to the overall PASE score as determined by the product of the sample mean and activity weight. The PASE questionnaire assesses involvement in half of these activities in terms of hours per day over a 7-day period; the other six items are scored 1 = engaged in activity or 0 = did not engage in that activity during the previous 7 days. As expected, the highest PASE weights were found for the more strenuous types of activity. The activities making the largest average individual contributions to the total PASE score were light housework, lawn work/yard care, walking, heavy housework, and jobs involving standing or walking.

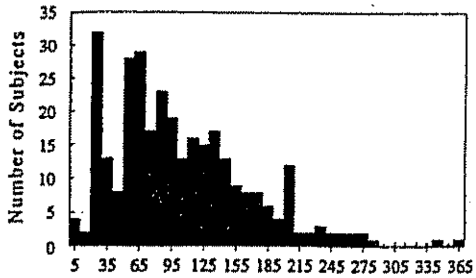

Fig. 2. Distribution of PASE scores in a general population age 65–100 yr.

PASE scores observed in this sample of older persons ranged from 0 to 360; the overall score distribution was skewed slightly to the right (Fig. 2). The mean sample score was 102.9 with a standard deviation of 64.1. The median score was 90. PASE scores declined with age and were consistently higher for men than women in each age group (Fig. 3).

Validation results

The results of the PASE validation analyses are summarized in Table 4 for the 222 subjects who completed a baseline instrument and the tests administered during the home visit. PASE scores were significantly associated with two of the three health status indicators, exhibiting

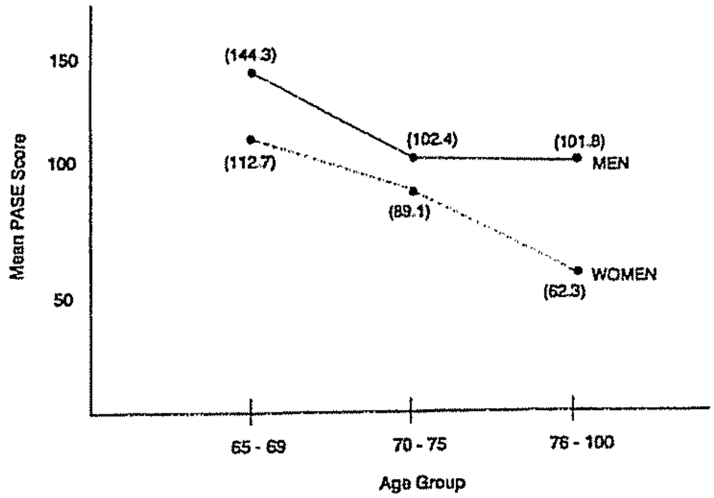

Fig. 3. Mean PASE score for men and women by age.

Table 4. Validity correlations for mail and telephone versions of PASE by mode, gender and age group

		Mode		Gender		Age group	
Validation measures	All subjects	Mail Questionnaire	Telephone Questionnaire	Female	Male	65–70	71–99
Perceived health (1 = excellent, 5 = poor)	−0.34**	−0.26*	−0.37**	−0.41**	−0.29**	−0.39**	−0.24**
Any restricted activity days (1 = yes, 0 = no)	−0.12	0.03	−0.21**	−0.23**	0.07	−0.16	−0.09
Sick Impact Profile Total Score	−0.42**	−0.42**	−0.46**	−0.37**	−0.40**	−0.36**	−0.42**
Heart rate	−0.13*	−0.32**	−0.01	−0.15	−0.03	−0.16	−0.12
Systolic BP	−0.09	−0.03	−0.14*	−0.19*	0.08	−0.09	0.01
Diastolic BP	−0.07	0.12	0.06	0.05	0.04	0.05	0.09
Body mass (kg/m^2)	0.01	−0.05	0.03	0.08	−0.04	−0.10	0.01
Grip strength	0.37**	0.34**	0.37**	0.40**	0.32**	0.26**	0.38**
Balance	0.33**	0.39**	0.33**	0.33**	0.29**	0.14	0.42**
Dominant leg strength	0.25**	0.24*	0.26**	0.32**	0.06	0.12	0.25**
Non-dominant leg strength	0.28**	0.23*	0.30**	0.33**	0.10	0.09	0.33**
n	222	78	144	120	102	103	119

*$p < 0.05$ (1-tailed); **$p < 0.01$ (1-tailed).

strong correlations with Sickness Impact Profile scores and perceived health status, but a much weaker relationship with restricted activity days in the previous week. PASE scores were also positively correlated with grip strength, static balance, and leg strength in both the dominant and non-dominant legs. Activity levels measured by PASE were not associated with body mass index or blood pressure readings in this sample. With few exceptions, these correlations were consistent by mode of administration, gender, and age group. The pattern of statistically significant correlations across a variety of health status and physiologic measures provides strong evidence for the convergent validity of the PASE scoring algorithm.

PASE scores exhibited seasonal variations (Fig. 4). As one would expect in New England, the highest levels of physical activity are reported during the summer months while the lowest levels occurred during the coldest months of winter. The correlation between average monthly temperatures and monthly PASE means in this sample was 0.83 (n = 12 months).

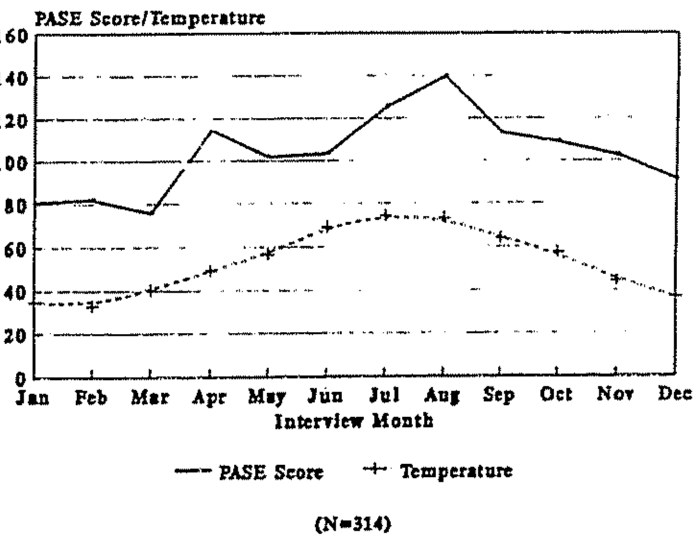

Fig. 4. Mean PASE scores and air temperatures by month of interview.

Table 5. Ordinary least squares regression of PASE score on sociodemographic factors and co-morbidity ($n = 282$)

Variable	Unstandardized coefficient	SE
Age (yr)	−1.93**	(0.56)
Gender (1 = female, 0 = male)	−16.88*	(6.76)
Race (1 = black/hispanic, 0 = white)	30.23	(18.73)
Lives alone	−11.26	(6.87)
Education (yr)	0.53	(1.24)
Employed	33.74**	(7.10)
Mode of administration (1 = mail, 0 = telephone)	17.83*	(6.56)
Average temperature (°F)	0.42	(0.22)
Sequence (1 = home visit first, 0 = home visit second)	1.28	(6.48)
Vision (1 = poor, 4 = excellent)	6.17	(4.64)
Current smoker	−13.69	(8.52)
Heart disease	−1.53	(7.89)
Cancer	21.48*	(8.43)
Hypertension	−16.30*	(6.14)
Arthritis	−5.06	(6.40)
Chronic respiratory disorder	−20.57*	(9.19)
Fracture	−4.00	(9.86)
Stroke	−8.30	(14.23)

Explanatory variables were coded: 1 = yes, 0 = no unless otherwise indicated.
*2 tailed $p \le 0.05$; **2 tailed $p \le 0.01$.

Sociodemographic and co-morbidity effects

Finally, Table 5 shows the multiple regression findings for sociodemographic and medical conditions hypothesized to affect physical activity for 282 subjects who completed both the baseline PASE and background questionnaires. This model accounted for nearly 38% of the variation in PASE scores.

Younger respondents, men, black and Hispanic subjects, and those who were employed all tended to have higher PASE scores than other members of the sample. Persons suffering from hypertension or chronic respiratory diseases had significantly lower PASE scores, while activity levels were higher than average for those with cancer. Scores also increased with outdoor temperature.

Controlling for demographic and health status variables, reported levels of physical activity were influenced by mode of administration. The mail version of PASE produced significantly higher activity scores (17.8 points on average) compared with telephone administration. Mail and telephone subjects were similar with respect to all but two covariates. Those responding by mail were more likely to be employed and to have suffered fractures than telephone respondents. The order in which subjects completed various components of this investigation, however, did not influence physical activity scores.

Test–retest reliability

Reliability was evaluated by determining the extent to which PASE scores were stable over repeated administrations. Two hundred fifty-four subjects completed both baseline and follow-up questionnaires over a 3–7 week interval. The test–retest reliability coefficient was 0.75 (95% CI = 0.69–0.80). Reliability for mail administration ($r = 0.84$) was higher than that for the telephone version of PASE ($r = 0.68$).

DISCUSSION

We have developed a physical activity survey for use with older people that is brief (5 minutes), easily scored, and can be administered by telephone, by mail or in person. Such an instrument suitable for use in studies of physical activity and health in older populations has not previously been available. The brevity of the PASE makes it feasible for use in large scale epidemiologic studies where limited time is available to assess physical activity.

The PASE was designed to assess activities commonly engaged in by older persons, thus avoiding one serious pitfall of age-neutral instruments. The focus of most age neutral physical activity surveys primarily on sport and recreational activity is not appropriate for older people. Our results underscore the importance of using a physical activity survey specific to older people. In the current study's sample, for example, the amount of time spent in all sport and recreational activity was only 5.4 minutes per day. However, considerable amounts of time were spent in other types of physical activity such as lawn work, caring for others, housework and gardening, activities which are underrepresented in age-neutral questionnaires.

The scoring procedures were developed using physical activity estimates derived from a representative sample of healthy, community-dwelling older individuals. Weights for individual activity areas were derived empirically to reflect each activity's contribution to overall physical activity as measured by three independent criterion measures. An important advantage of this approach to constructing scoring rules is that it avoids having to make questionable assumptions needed to estimate caloric expenditure of individual activities based on recall of the frequency, intensity and duration of the activity. Obtaining the detailed information needed to generate accurate caloric expenditure estimates is beyond the scope of a brief physical activity assessment instrument.

Comparisons with data collected during home visits provide strong evidence for the convergent validity of the PASE. The correlations between PASE scores and health status, strength and balance were all in the hypothesized direction and of moderate strength (range $r = 0.25$ to $r = 0.42$). Larger correlations would not be expected given the influence of factors other than physical activity on health-related variables. Only one other study has assessed the validity of physical activity questionnaire with older respondents. However, this analysis was based on a small, non-representative sample using only 24-hour activity recalls and pedometer counts as validation criteria [38].

The PASE test–retest reliability coefficient (0.75) exceeds those reported for other physical activity surveys. Sallis *et al.* [20], for example, reported a 2 week test–retest correlation of 0.67 for the Five-Cities Activity survey in 53 men and women of a mean age of 41. In a random population sample of 633 men and women, ages 25–65 years, Washburn *et al.* [39] reported a 7–12 week test–retest correlation for the Harvard Alumni Physical Activity survey of 0.58. Like the PASE, both the Five-Cities and Harvard Alumni surveys are based on 7 day recalls. In the current study, discordance between physical activity estimates over the 3–7 week follow-up period can reflect actual changes in physical activity as well as unreliable reporting. In this context, the PASE test–retest correlations of 0.68 for telephone and 0.84 for mail administration are comparatively large for a physical activity assessment instrument.

The observed effect of mode of administration on physical activity estimates is of concern. Our results indicated that PASE scores were nearly 18 points higher, on average, when the PASE was administered by mail compared to telephone. The direction of this effect suggests that the observed difference was most likely due to respondents' double reporting activities in the mail version of PASE. For example, field staff indicated that subjects reported walking in response to the question specifically on walking and again under light or moderate recreational activity. This did not occur in the telephone version where the interviewer could probe in response to questionable information. However, interviewer probing may introduce inconsistency in the responses and be responsible for the lower test–retest reliability seen with the telephone version. The high reliability coefficient for mail administration indicates that random error is not a major problem with the mail version of the instrument.

Because of these concerns, we recommend that the telephone version of PASE be the method of first choice and suggest that the mail questionnaire be used in a modified form. Additional respondent instructions have been added to the mail version clarifying the proper categorization of activities. These clarifications should reduce reporting error in the mail version. The revised mail version of PASE, however, should be field tested to confirm that the recording problem has been corrected. Although we did not specifically evaluate the reliability and validity of a face-to-face version of PASE, our experiences with telephone interview administration suggest this mode of administration should provide reliable and valid physical activity assessments.

This investigation was unique in applying an empirical approach to constructing a physical activity instrument and in evaluating it in a probability sample of community-dwelling older adults. Although our analysis reveals that participants as compared with non-participants were slightly younger and more likely to be male, there were no differences between participants and non-participants in employment, perceived health, concern about health or level of physical activity. This implies that the validation and reliability results may be generalized to the population of community-dwelling older persons. The substantive finding that physical activity of older persons, as measured by PASE, is related to age, gender, employment status, and chronic respiratory disease factors in this sample were consistent with the literature [40, 41]. It is not clear, however, why PASE scores for those individuals reporting cancer were higher than average unless many of these cancers were in remission.

Future administration of PASE in larger samples of older persons will be needed to develop normative values of physical activity in older persons. In addition, it is important to determine the sensitivity of PASE in detecting change in physical activity to assess its utility as an evaluation instrument.

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