

Differences in Exercise Performance and Leisure-Time Physical Activity in Older Men and Women

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Abstract

Purposes: (a) To compare exercise performance and leisure-time physical activity (LTPA) between older men and women, (b) to assess the relationship between exercise performance and LTPA, and (c) to determine whether group differences in exercise performance persist after controlling for LTPA.

Methods: A total of 105 women and 155 men who were 65 years of age and older participated in this study. Subjects were characterized on exercise performance by a 6-minute walk test, and by a short physical performance battery (SPPB) consisting of a repeated chair rise test, a standing balance test, and a 4-meter walk test. Additionally, LTPA was assessed using the Minnesota LTPA questionnaire.

Results: Women had a 7% lower SPPB value ($P < 0.001$), a 12% shorter 6-minute walk distance ($P < 0.001$), and a 28% lower LTPA value ($P < 0.011$) than the older men. LTPA was significantly related ($P < 0.01$) to both SPPB and 6-minute walk distance in the older men and women. Group differences in SPPB and 6-minute walk distance between older men and women were no longer present ($P > 0.05$) after controlling for LTPA.

Conclusions: Older women have impaired exercise performance and lower LTPA compared to older men. Furthermore, sex differences in exercise performance no longer exist after controlling for LTPA.

Keywords: age, exercise, gender, physical function

Introduction

Assessment of exercise performance in older adults is clinically useful because declines typically precede the onset of disability.^{1,2} Several simple and objective performance measures of exercise performance include the short physical performance battery (SPPB)²⁻⁵ and the 6-minute walk test.⁶⁻⁹ The SPPB is a composite measure of walking velocity, standing balance, and repeated chair rise performance,³ and it is a predictor of mortality, loss of mobility, and nursing home admission.^{2,4,5} The 6-minute walk test is a measure of ambulatory function and exercise capacity in various populations,⁶⁻⁹ and it also is a predictor of mortality and morbidity.⁷

Because a decline in exercise performance may be a precursor to the onset of disability and subsequent complications, the factors related to exercise performance in older men and women are important to identify. Physical activity is one lifestyle modification that can decrease the risk of mortality,^{10,11} morbidity,^{10,12} development of disability,^{13,14} and decline in exercise performance¹⁵ in older adults. Several studies report that older women have impaired exercise performance¹⁶ and lower levels of leisure-time physical activity (LTPA) than older men,¹⁷⁻²⁰ but it is not clear whether the sex differences in exercise performance are related to differences in LTPA.

The purposes of this study were to (a) compare exercise performance and LTPA between older men and women, (b) assess the relationship between exercise performance and LTPA, and (c) determine whether group differences in exercise performance persist after controlling for LTPA.

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Methods

Subjects

Recruitment

A total of 367 subjects were recruited for this study via local newspaper advertisements for a free evaluation of exercise performance and physical activity levels. At the beginning of the study visit, subjects agreed to participate by signing the informed consent form that was approved by the Institutional Review Board at the University of Maryland, Baltimore.

Inclusion and exclusion criteria

To meet the inclusion criteria for this study, all subjects were 65 years of age and older, ambulatory, and lived independently at home. The exclusion criteria were evaluated by administering a medical history questionnaire. Subjects were excluded from this study for having a history of coronary artery disease, stroke, congestive heart failure, peripheral arterial disease, chronic obstructive pulmonary disease, and renal disease.

Measurements

Demographic information

Age, sex, race, cardiovascular disease risk factors, and co-morbid conditions were obtained during the medical history interview to begin the evaluation. Height was recorded from a stadiometer (SECA, Germany) and body weight was recorded from a balance beam scale (Health-O-Meter Inc., Bridgeview, IL) after the subjects removed their shoes. From these measurements, body mass index was calculated as follows: weight (kg)/height (m²).

SPPB

Exercise performance was measured by calculating the SPPB score based on the performance of completing a repeated chair rise test, a standing balance test, and a 4-meter walk test. For each of the three tests, subjects are scored on a 0 to 4 ordinal scale, with a score of 0 representing inability to perform the test, and scores between 1 and 4 representing quartiles of performance based on normative data on more than 5,000 community-dwelling people

published from the Established Populations for the Epidemiologic Studies of the Elderly.² The SPPB score is the sum of the three test scores ranging between 0 to 12, with a score of 0 representing the worst possible performance and a score of 12 representing the best possible performance. The SPPB is a predictor of mortality, disability, and nursing home admission in older community-dwelling men and women.^{2,4,5} In a sub-sample of 44 subjects tested twice in our laboratory within two weeks, the test-retest intraclass reliability coefficient and coefficient of variation were 0.84 and 11.5% for the SPPB score.

Repeated chair rise

Lower extremity strength and balance were assessed by performing a repeated chair rise test in which subjects completed five sequential sit-to-stand transfers from an armless 18-inch high, straight-backed chair with their arms folded across their chest as previously described.²¹ Subjects were instructed to perform this test as quickly as possible, and were timed by a trained research technician with the aid of a stopwatch. In the sub-sample of 44 subjects, the test-retest intraclass reliability coefficient and coefficient of variation were 0.89 and 6.4% for the time to complete the repeated chair rise test.

Standing balance

Balance was assessed by measuring the time that subjects could hold a stance in side-by-side, semitandem, and full-tandem positions as previously described.²² Subjects stood in each of the three increasingly difficult positions for up to a maximum of 10 seconds, with brief rest periods separating the tests. A research technician timed the tests while standing next to the subject. The test-retest intraclass reliability coefficients for the time that subjects could stand in the three respective positions were 0.99, 0.99, and 0.95, and the coefficients of variation were 0.3%, 0.7%, and 3.2%.

4-Meter walking velocity

Walking velocity was assessed by measuring the time required for subjects to walk a distance of four meters marked out in a corridor at their usual pace.³ The subjects stood with their feet together behind the starting line, and were instructed to walk approximately one meter beyond the finish line to avoid slowing down prior to completing the test.

A research technician stood in the middle of the 4-meter course and began timing when one foot crossed the starting line and stopped timing when one foot crossed the finish line. The subjects performed two trials, and the faster of the two was used in the statistical analyses.^{2,5,23} The test-retest intraclass reliability coefficient and coefficient of variation were 0.96 and 2.4% for the velocity to walk four meters.

6-Minute walk test

In addition to the tests comprising the SPPB, exercise performance also was determined by measuring ambulatory function during an endurance test. Subjects performed an over ground, 6-minute walk test supervised by a trained research technician as previously described.⁹ Briefly, two cones were placed 100 feet apart in a marked corridor. Subjects were instructed to walk as many laps around the cones as possible while the research technician timed the test using a stopwatch. The research technician stood at the center of the 100-foot course and provided encouragement every two minutes. Subjects were permitted to stop walking during the test, if necessary, and to resume walking as soon as they could. At completion of the test, the technician recorded the total distance walked. The test-retest intraclass reliability coefficient and coefficient of variation were 0.94 and 10.4% for the total distance covered during the 6-minute walk test.⁹

LTPA

The Minnesota LTPA Questionnaire was administered to determine the activity level of the subjects over the preceding year.²⁴ The Minnesota LTPA yields an average daily energy expenditure of physical activity (kcal/d). During a structured interview, subjects were asked whether they had performed various activities over the past year. For each activity performed, the frequency and duration were multiplied by the metabolic equivalent of the activity (i.e. the intensity) to obtain a yearly total of energy expenditure, which was subsequently divided by 365 to convert to a daily value. The Minnesota LTPA is highly correlated ($r = 0.74$) with the energy expenditure of physical activity (EEPA) derived by the DLW and indirect calorimetry methods in apparently healthy individuals.²⁵ The test-retest reliability coefficient of this measure has ranged between 0.78 and 0.88.²⁶

Statistical analyses

Unpaired *t*-tests and Chi-square tests were performed to assess whether differences existed between the older men and women on continuous and categorical data, respectively. Pearson product-moment correlation coefficients and Spearman rank-order correlation coefficients were calculated to determine the association between exercise performance and LTPA. Analysis of covariance (ANCOVA) was then used to assess whether group differences in exercise performance persisted after controlling for LTPA. All analyses were performed using the SPSS-PC statistical package (version 10.0). Statistical significance was set at $P < 0.05$. Measurements are presented as means $\pm$ SD.

Results

The demographic measurements of the older men and women are displayed in Table 1. Women were shorter in stature and weighed less than men ($P < 0.001$), resulting in no difference in BMI ($P = 0.850$). The two groups were similar in age ($P = 0.967$), racial composition ($P = 0.673$), smoking history ($P = 0.285$), as well as having diabetes ($P = 0.922$), hypertension ($P = 0.718$), and hyperlipidemia ($P = 0.901$).

The exercise performance and LTPA measurements of the older men and women are shown in Table 2. Women had a 5% lower SPPB score ($P < 0.001$), an 11% lower performance score for repeated chair rise ($P < 0.029$), an 5% lower performance score for standing balance ($P < 0.001$), and a 3% lower performance score for walking velocity ($P < 0.033$) than men. Additionally, the older women had a 12% shorter 6-minute walk distance ($P < 0.001$), and were 28% less physically active ($P < 0.011$) than the older men.

The correlation coefficients between exercise performance and LTPA in the older men and women are displayed in Table 3. LTPA was significantly related ($P < 0.05$) to each exercise performance measure within each group, as well as in a combined group. Group differences in the exercise performance measures between older men and women were no longer present ($P > 0.05$) after controlling for LTPA (Table 4).

Discussion

The older women in this study had a 7% lower SPPB score than the older men. Consequently, the lower exercise performance of non-disabled

Table 1. Demographic measurements of older men (n = 155) and women (n = 105). Values are means (SD) or percentages.

Variables	Men	Women	P value
Age (years)	71 (5)	71 (4)	0.967
Height (cm)	174.3 (7.4)	161.4 (6.3)	<0.001
Weight (kg)	87.1 (14.7)	74.4 (12.6)	<0.001
Body mass index	28.6 (4.1)	28.5 (4.7)	0.850
Race			0.673
(% Caucasian)	58	54	
(% African-American)	42	46	
Smoking			0.285
(% Never)	51	57	
(% Former)	43	35	
(% Current)	6	8	
Diabetes (%)	13	12	0.922
Hypertension (%)	44	45	0.718
Hyperlipidemia (%)	45	47	0.901

older women suggests that they are at greater risk for subsequent disabling and co-morbid conditions, nursing home admission, and mortality than their male counterparts.^{2,4,5,27} The lower SPPB score of the older women resulted from lower performance values in each of the three components. Thus, older women had impaired exercise performance in the domains of lower extremity strength, balance, and ambulation compared to older men. This finding is in agreement with a recent study that reported a 14% lower score for the repeated chair rise task, a 13% lower score for the walking test, and a 14% lower SPPB score

combining these two tests in older Caucasian women compared to older Caucasian men.¹⁶ Similarly, older African-American women had 5%, 25%, and 15% lower values than older African-American men in the three respective measures.¹⁶

In addition to the SPPB score and its' components, the older women in this investigation covered a 12% shorter distance during the 6-minute walk test than the older men. This finding indicates that the older women had impaired ambulatory function during an endurance-related test. The shorter walking distance of the older women may be related to lower cardiopulmonary fitness^{9,28} as well as

Table 2. Exercise performance and leisure-time physical activity measurements of older men (n = 155) and women (n = 105). Values are means (SD).

Variables	Men	Women	P value
SPPB score (0–12 scale, 12 = best)	10.6 (1.2)	9.9 (1.3)	<0.001
Repeated chair rise score (0–4 scale, 4 = best)	2.7 (1.1)	2.4 (1.1)	0.029
Standing balance score (0–4 scale, 4 = best)	3.8 (0.6)	3.6 (0.5)	<0.001
Walking velocity score (0–4 scale, 4 = best)	4.0 (0.2)	3.9 (0.3)	0.033
6-Minute walk distance (meters)	492 (101)	433 (86)	0.001
Leisure-time physical activity (kcal/d)	236 (239)	169 (181)	0.011

SPPB: short physical performance battery.

Table 3. Correlation coefficients of exercise performance variables with leisure-time physical activity in older men (n = 155), older women (n = 105), and in a combined group (n = 260).

Functional status variables	Men	Women	Combined
SPPB score	0.42*	0.33*	0.37*
Repeated chair rise score	0.31*	0.29*	0.26*
Standing balance score	0.39*	0.37*	0.35*
Walking velocity score	0.23*	0.32*	0.27*
6-Minute walk distance	0.34*	0.41*	0.37*

SPPB: short physical performance battery.

* $P < 0.01$.

impaired lower extremity strength.⁶ In a previous investigation in our laboratory, the 6-minute walk distance was significantly related to peak oxygen uptake in older patients with peripheral arterial disease limited by intermittent claudication.⁹ Furthermore, a recent study found a significant relationship between lower extremity strength and the 6-minute walk distance in older adults.⁶

The older women in this study were 28% less physically active than compared to the older men, supporting the findings of previous investigations.¹⁶⁻²⁰ Data from the third National Health and Nutritional Examination Survey indicate that physical inactivity was 12% more prevalent in women than in men between the ages of 60 and 69 years, and was 17% more prevalent in those between the ages of 70 and 79 years.¹⁷ Additionally, the prevalence of participating in LTPA five or more times per week was approximately 10% lower in women than in men 60 years of age and older.¹⁸ In a recent investigation assessing the

physical activity during the previous seven days with a questionnaire, older Caucasian and African-American women reported 50% and 44% less physical activity than their older male counterparts, respectively.¹⁶ Consequently, the 28% lower LTPA value reported by the older, non-disabled women in this investigation confirms previous studies, and may negatively impact on their exercise performance and increase the risk of future disability.

LTPA was significantly related to each exercise performance measure in the men, women, and a combined group of men and women in this investigation. The strength of association between LTPA and the SPPB score, as well as each of the three component performance scores, was similar in the older men and women. This finding suggests that LTPA was equally important in maintaining lower extremity strength, balance, and ambulatory function in older men and women. Furthermore, the strength of association between LTPA and 6-minute walk distance

Table 4. Adjusted* exercise performance measurements of older men (n = 155) and women (n = 105). Values are means (SD).

Variables	Men	Women	P value
SPPB score (0–12 scale, 12 = best)	10.3 (1.2)	10.2 (1.3)	0.320
Repeated chair rise score (0–4 scale, 4 = best)	2.6 (1.1)	2.5 (1.1)	0.398
Standing balance score (0–4 scale, 4 = best)	3.8 (0.6)	3.8 (0.5)	0.264
Walking velocity score (0–4 scale, 4 = best)	3.9 (0.2)	3.9 (0.3)	0.802
6-Minute walk distance (meters)	473 (5)	457 (6)	0.255

SPPB: short physical performance battery.

*Values were adjusted for leisure-time physical activity.

was similar between the two groups, and was similar to the relationship between LTPA and SPPB scores. This suggests that LTPA of older men and women impacts on cardiopulmonary fitness⁹ in addition to lower extremity strength, balance, and ambulatory function. Differences in all of the exercise performance measurements between the men and women were no longer present after controlling for LTPA, suggesting that the lower exercise performance of older women was explained by their lower level of LTPA. Therefore, identifying barriers to physical activity and developing interventions to increase physical activity in older, non-disabled women may have a significant impact on their exercise performance and reduce the risk of subsequent disability.

Although the results of this study suggest that differences in exercise performance between older men and women were related to differences in LTPA, several limitations exist. First, the cross-sectional design of this study does not infer a cause and effect relationship between LTPA and exercise performance. Second, although it is possible that a low level of LTPA leads to low exercise performance, it is also plausible that low exercise performance results in low LTPA in older men and women. Third, the assessment of LTPA was obtained via questionnaire, and therefore is subject to inherent limitations such as recall errors and bias. However, the Minnesota LTPA questionnaire is a reliable and valid measure of daily physical activity in older adults.²⁵ The primary strengths of this study include a relatively large sample of older men and women who were well-characterized on a number of performance tests to quantify exercise performance.

In summary, the major findings of this investigation were: (a) older women were lower on measures of exercise performance, and were less physically active than compared to older men, (b) physical activity was significantly related to each measure of exercise performance in men, women, and all subjects combined, and (c) the exercise performance of older women was similar to that of older men after adjusting for group differences in LTPA. In conclusion, older women have impaired exercise performance and lower LTPA compared to older men. Furthermore, sex differences in exercise performance no longer exist after controlling for LTPA.

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