

Differences in Exercise Performance and Leisure-Time Physical Activity in Older Caucasians and African-Americans

Andrew W. Gardner^{1,2} and Polly S. Montgomery^{1,2}

¹CMRI Metabolic Research Center, University of Oklahoma Health Sciences Center, Oklahoma City, OK. ²Department of Medicine, Division of Gerontology, University of Maryland, Baltimore, MD.

Abstract

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

Methods: A total of 207 Caucasians and 160 African-Americans 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) score 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: African-Americans had a 5% lower SPPB value ($p < 0.009$), a 14% shorter 6-minute walk distance ($p < 0.001$), and a 34% lower LTPA value ($p < 0.020$). LTPA was significantly related ($p < 0.01$) to both SPPB and 6-minute walk distance in both groups. Differences in SPPB and 6-minute walk distance between older Caucasians and African-Americans were no longer present ($p > 0.05$) after controlling for LTPA.

Conclusions: Older African-Americans had impaired exercise performance and lower LTPA compared to older Caucasians. Racial differences in exercise performance were no longer present after adjusting for differences in LTPA.

Introduction

Older African-Americans have up to 50% greater prevalence of disability than older Caucasians (1,2). The high prevalence of functional limitations (1), particularly lower body physical function (3), contribute to the relatively high disability rate in older African-Americans. These impairments in older African-Americans has been determined by self-report in most (1,3,4), but not in all (5) investigations. Self-report measures are limited by reduced sensitivity to gradual functional loss in non-disabled older African-Americans who may experience subtle declines in exercise performance long before the development of physical disability. The short physical performance battery (SPPB) (6–10) and the 6-minute walk test (11–16) are two simple and objective measures of exercise performance. These measures are predictors of mortality (8,12), morbidity (8), loss of mobility (7,10), and nursing home admission (8).

Physical activity is one lifestyle modification that can decrease the risk of mortality (17,18), morbidity (17,19), development of disability (20–22), and decline in exercise performance (23,24) in older adults. Several studies report that older African-Americans have lower levels of leisure-time physical activity (LTPA) (5,25–29) and are less likely to walk at least eight blocks per week (30) than older Caucasians. However, it is not clear whether the racial 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 Caucasians and African-Americans, (b) assess the relationship between exercise performance and LTPA in both groups, and (c) determine whether group differences in exercise performance persist after controlling for LTPA.

Correspondence: Andrew W. Gardner, Ph.D., Hobbs-Recknagel Professor, CMRI Metabolic Research Center, University of Oklahoma Health Sciences Center, 1122 N.E. 13th Street, ORI-W 1400, Oklahoma City, OK 73117. Tel: (405) 271-4272, ext. 42743; Fax: 405-271-4273; Email: andrew-gardner@ouhsc.edu



Copyright in this article, its metadata, and any supplementary data is held by its author or authors. It is published under the Creative Commons Attribution By licence. For further information go to: <http://creativecommons.org/licenses/by/3.0/>.

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 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, education, 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 (8). 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 score is a predictor of mortality, disability, and nursing home admission in older community-dwelling men and women (7,8,10). In a subsample 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 (31). 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 subsample 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, semi-tandem, and full-tandem positions as previously described (32). 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 (6). 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 (8,10,33). 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 score, 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 (17). 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 (15).

LTPA

The Minnesota LTPA Questionnaire was administered to determine the activity level of the subjects over the preceding year (34). 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 ($r = 0.83$) with the energy expenditure of physical activity (EEPA) derived by the DLW and indirect calorimetry methods in apparently healthy individuals (35).

The test-retest reliability coefficient of this measure has ranged between 0.78 and 0.88 (36).

Statistical analyses

Unpaired *t*-tests and Chi-square tests were performed to assess whether differences existed between the older Caucasians and African-Americans on continuous and categorical data, respectively. Analysis of covariance (ANCOVA) was performed to assess group differences in exercise performance and LTPA after adjusting for significant demographic characteristics. Pearson product-moment correlation coefficients and Spearman rank-order correlation coefficients were calculated to determine the association between exercise performance and LTPA. All analyses were performed using the SPSS-PC statistical package (version 11.5). Statistical significance was set at $p < 0.05$. Measurements are presented as means $\pm$ SD.

Results

The demographic measurements of the older Caucasians and African-Americans are displayed in Table 1. The two groups were similar on all characteristics ($p > 0.05$) except that a higher percentage of Caucasians had a high school degree than African-Americans ($p < 0.05$).

The exercise performance and LTPA measurements of the older Caucasians and African-Americans, adjusted for education level, are shown in Table 2. African-Americans had a 5% lower SPPB score ($p < 0.009$), and 11% lower performance score for repeated chair rise ($p < 0.046$), and a 5% lower performance score for walking velocity ($p < 0.001$) than Caucasians. Additionally, African-Americans had a 14% shorter 6-minute walk distance ($p < 0.001$), and were 34% less physically active ($p < 0.020$) than Caucasians.

The correlation coefficients between exercise performance and LTPA in the older men and women are displayed in Table 3. LTPA was significantly related ($p < 0.01$) to each exercise performance measure within each group, as well as in a combined group. Group differences in the exercise performance measures between older Caucasians and African-Americans were no longer present ($p > 0.05$) after controlling for LTPA and education level (Table 4).

Table 1. Demographic measurements of older caucasians (n = 207) and African-Americans (n = 160). Values are means (SD) and percentages.

Variables	Caucasian	African-American	P Value
Age (years)	71 (4)	71 (4)	0.689
Height (cm)	171.6 (8.8)	170.5 (9.3)	0.551
Weight (kg)	84.1 (15.1)	85.2 (15.6)	0.287
Body mass index	28.4 (4.1)	29.3 (4.7)	0.181
Sex (% Men)	62	60	0.312
Smoking			0.171
(% Never)	52	56	
(% Former)	42	36	
(% Current)	6	8	
Diabetes (%)	11	20	0.078
Hypertension (%)	48	62	0.160
Hyperlipidemia (%)	42	40	0.793
High school degree (%)	83	58	0.004

Discussion

The older African-Americans in this study had a 5% lower SPPB score than the older Caucasians. Consequently, the lower exercise performance of non-disabled older African-Americans suggests that they are at greater risk for subsequent disabling and co-morbid conditions, nursing home admission, and

mortality than their Caucasian counterparts (7,8,10,37). The lower SPPB score of the African-Americans resulted from lower performance values in the repeated chair rise and walking velocity components. Thus, older African-Americans had impaired exercise performance in the domains of lower extremity strength and ambulation compared to older Caucasians. These findings are in agreement with a study that reported a 21% and 22% lower SPPB score in older African-American men and women than in older Caucasian men and women, respectively (5). Furthermore, other studies indicate that older African-Americans self-report greater lower body disability (20,29), worse physical function (3), greater impairment in activities of daily living (29), and lower likelihood of walking at least eight blocks (30) or one mile (20,29) than older Caucasians.

In addition to the SPPB score and its' components, the older African-Americans in this investigation covered a 14% shorter distance during the 6-minute walk test than the older Caucasians. This finding indicates that the older African-Americans had impaired ambulatory function during an endurance-related test. The shorter walking distance of the older African-Americans may be related to lower cardiopulmonary fitness (15,38) as well as impaired lower extremity strength (11). The greater impairment in the repeated chair rise task by the African-Americans in the present investigation and in a previous report (5) supports the notion that their lower 6-minute walk distance may have been partially due to impaired lower extremity strength.

Table 2. Exercise performance and leisure-time physical activity measurements of older caucasians (n = 207) and African-Americans (n = 160). Values are Means (SD).

Variables	Caucasian	African-American	P Value
SPPB score (0–12 scale, 12 = best)	10.4 (1.2)	9.9 (1.3)	0.009
Repeated chair rise score (0–4 scale, 4 = best)	2.7 (1.1)	2.4 (1.1)	0.046
Standing balance score (0–4 scale, 4 = best)	3.8 (0.6)	3.8 (0.4)	0.937
Walking velocity score (0–4 scale, 4 = best)	3.9 (0.2)	3.7 (0.3)	0.001
6-Minute walk distance (meters)	487 (99)	420 (91)	0.001
Leisure-time physical activity (kcal/d)	245 (234)	162 (168)	0.020

Abbreviation: SPPB: short physical performance battery.

^aValues adjusted for education level.

Table 3. Correlation coefficients of exercise performance variables with leisure-time physical activity in older caucasians (n = 207), African-Americans (n = 160), and in a combined group (n = 367).

Exercise performance variables	Caucasian	African-American	Combined
SPPB score	0.35*	0.37*	0.37*
Repeated chair rise score	0.23*	0.31*	0.26*
Standing balance score	0.37*	0.20*	0.35*
Walking velocity score	0.23*	0.30*	0.27*
6-Minute walk distance	0.31*	0.60*	0.37*

Abbreviation: SPPB: short physical performance battery.

*P < 0.01.

The older African-Americans in this study were 34% less physically active than compared to the older Caucasians, supporting the findings of previous investigations (25–29). Data from the third National Health and Nutritional Examination Survey indicate that the age-adjusted prevalence of not participating in LTPA was higher in African-Americans (35%) than in Caucasians (18%) (26), and that the prevalence of participating in LTPA at least five times per week was lower in older African-Americans than in older Caucasians (25). Furthermore, fewer older African-Americans report regularly exercising (20,29) or getting enough exercise (29). In a recent investigation assessing the physical activity during the previous seven days with a questionnaire, older African-American men and women reported 39% and 31% less physical activity than their Caucasian counterparts, respectively (5). Consequently, the 34% lower level of LTPA in the older African-Americans 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 Caucasians, African-Americans, and a combined group in this investigation. This finding suggests that LTPA was equally important in maintaining components of exercise performance (lower extremity strength, balance, and ambulation) in older Caucasians and African-Americans. Furthermore, the strength of association between LTPA and 6-minute walk distance was higher in the older African-Americans than in the Caucasians, suggesting that a physically active lifestyle is particularly important in maintaining ambulatory function in older African-Americans. This notion is supported by a longitudinal study that found walking at least four times per week had a greater protective effect against an increase in lower body disability in older African-Americans than in older Caucasians (20).

Differences in all of the exercise performance measurements between the Caucasians and African-Americans were no longer present after controlling for LTPA, suggesting that the lower exercise performance of older African-Americans was explained

Table 4. Adjusted* exercise performance measurements of older caucasians (n = 207) and African-Americans (n = 160). values are means (SD).

Variables	Caucasian	African-American	P Value
SPPB score (0–12 scale, 12 = best)	10.2 (1.2)	10.1 (1.3)	0.240
Repeated chair rise score (0–4 scale, 4 = best)	2.6 (1.1)	2.5 (1.1)	0.341
Standing balance score (0–4 scale, 4 = best)	3.8 (0.6)	3.8 (0.4)	0.750
Walking velocity score (0–4 scale, 4 = best)	3.8 (0.2)	3.8 (0.3)	0.812
6-Minute walk distance (meters)	478 (99)	468 (91)	0.452

Abbreviation: SPPB: short physical performance battery.

*Values adjusted for education level and leisure-time physical activity.

by their lower level of LTPA. Therefore, identifying barriers to physical activity and developing interventions to increase physical activity in older, non-disabled African-Americans 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 Caucasians and African-Americans were related to differences in LTPA, several limitations exist. The cross-sectional design of this study does not infer a cause and effect relationship between LTPA and exercise performance. 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 Caucasians and African-Americans. Additionally, the assessment of physical activity 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 (35). The primary strengths of this study include a relatively large sample of older Caucasians and African-Americans who were well-characterized on a number of measurements to quantify exercise performance.

In summary, the major findings of this investigation were: (a) older African-Americans were 5–28% lower on measures of exercise performance and were 34% less physically active than compared to older Caucasians, (b) physical activity was significantly related to each measure of exercise performance, and (c) the exercise performance of older African-Americans was similar to that of older Caucasians after adjusting for group differences in LTPA. In conclusion, older African-Americans had impaired exercise performance and lower LTPA compared to older Caucasians. Furthermore, racial differences in exercise performance were no longer present after adjusting for differences in LTPA.

Acknowledgments

Supported by grants from the National Institute on Aging (NIA) (R01-AG-16685, K01-00657; AWG), the University of Oklahoma Health Sciences Center General Clinical Research Center grant (M01-RR-14467) sponsored by the National Center for Research Resources from the National Institutes of Health, and by a University of Oklahoma Research Council grant.

References

- [1] Clark, D.O. and Maddox, G.L. 1992. Racial and social correlates of age-related changes in functioning. *J. Gerontol: Soc. Sci.*, 47: S222–S232.
- [2] Ford, A.B., Haug, M.R., Jones, P.K., Roy, A.W. and Folmar, S.J. 1990. Race-related differences among elderly urban residents: A cohort study, 1975–1984. *J. Gerontol: Soc. Sci.*, 45:S163–S171.
- [3] Clark, D.O., Mungai, S.M., Stump, T.E. and Wolinsky, F.D. 1997. Prevalence and impact of risk factors for lower body difficulty among Mexican Americans, African Americans, and Whites. *J. Gerontol. A. Biol. Sci. Med. Sci.*, 52A:M97–M105.
- [4] Rimmer, J.H., Rubin, S.S., Braddock, D. and Hedman, G. 1999. Physical activity patterns of African-American women with physical disabilities. *Med. Sci. Sports Exerc.*, 31:613–8.
- [5] Visser, M., Kritchevsky, S.B., Goodpaster, B.H. et al. 2002. Leg muscle mass and composition in relation to lower extremity performance in men and women aged 70 to 79: The Health, Aging and Body Composition Study. *J. Am. Geriatr. Soc.*, 50:897–904.
- [6] Guralnik, J.M., Ferrucci, L., Pieper, C.F. et al. 2000. Lower extremity function and subsequent disability: Consistency across studies, predictive models, and value of gait speed alone compared with the short physical performance battery. *J. Gerontol. A. Biol. Sci. Med. Sci.*, 55A: M221–M231.
- [7] Guralnik, J.M., Ferrucci, L., Simonsick, E.M., Salive, M.E. and Wallace, R.B. 1995. Lower extremity function in person over the age of 70 years as a predictor of subsequent disability. *New Engl. J. Med.*, 332:556–61.
- [8] Guralnik, J.M., Simonsick, E.M., Ferrucci, L. et al. 1994. A short physical performance battery assessing lower extremity function: association with self-reported disability and prediction of mortality and nursing home admission. *J. Gerontol. Med. Sci.*, 49:M85–M94.
- [9] McDermott, M.M., Greenland, P., Ferrucci, L. et al. 2002. Lower extremity performance is associated with daily life physical activity in individuals with and without peripheral arterial disease. *J. Am. Geriatr. Soc.*, 50:247–55.
- [10] Ostir, G.V., Markides, K.S., Black, S.A. et al. 1998. Lower body functioning as a predictor of subsequent disability among older Mexican Americans. *J. Gerontol. A. Biol. Sci. Med. Sci.*, 53A:M491–M495.
- [11] Bean, J.F., Kiely, D.K., Leveille, S.G. et al. 2002. The 6-minute walk test in mobility-limited elders: What is being measured? *J. Gerontol. A. Biol. Sci. Med. Sci.*, 11:M751–756.
- [12] Bittner, V., Weiner, D.H., Yusuf, S. et al. 1993. Prediction of mortality and morbidity with a 6-minute walk test in patients with left ventricular dysfunction. *JAMA*, 270:1702–7.
- [13] Guyatt, G., Sullivan, M. and Thompson, P. 1985. The 6-minute walk: A new measure of exercise capacity in patients with chronic heart failure. *Can. Med. Assoc. J.*, 132:919–23.
- [14] Lipkin, D., Scriven, A., Crake, T. and Poole-Wilson, P. 1986. Six-minute walking test for assessing exercise capacity in chronic heart failure. *Br. Med. J.*, 292:653–5.
- [15] Montgomery, P.S. and Gardner, A.W. 1998. The clinical utility of a six-minute walk test in peripheral arterial occlusive disease patients. *J. Am. Geriatr. Soc.*, 46:706–11.
- [16] Rozkovec, A., Papouchado, M., James, M., Kendrick, A.H., Clarke, L.M. and Rees, J.R. 1989. The relationship of symptoms to performance in paced patients with breathlessness. *Eur. Heart J.*, 10:63–9.
- [17] Bijnen, F.C.H., Caspersen, C.J., Feskens, E.J.M., Saris, W.H.M., Mosterd, W.L. and Kromhout, D. 1998. Physical activity and 10-year mortality from cardiovascular disease and all causes: The Zutphen Elderly Study. *Arch. Intern. Med.*, 158:1499–505.
- [18] Wannamethee, S.G., Shaper, A.G. and Walker, M. 1998. Changes in physical activity, mortality, and incidence of coronary heart disease in older men. *Lancet*, 351:1603–8.
- [19] Hu, F.B., Leitzmann, M.F., Stampfer, M.J., Colditz, G.A., Willett, W.C. and Rimm, E.B. 2001. Physical activity and television watching in relation to risk for type 2 diabetes mellitus in men. *Arch. Intern. Med.*, 161:1542–8.

- [20] Clark, D.O. 1996. The effect of walking on lower body disability among older blacks and whites. *Am. J. Public Health*, 86:57–61.
- [21] LaCroix, A.Z., Guralnik, J.M., Berkman, L.F., Wallace, R.B. and Satterfield, S. 1993. Maintaining mobility in late life II. *Am. J. Epidemiol.*, 137:858–69.
- [22] Simonsick, E.M., Lafferty, M.E., Phillips, C.L. et al. 1993. Risk due to inactivity in physically capable older adults. *Am. J. Public Health*, 83:1443–50.
- [23] Seeman, T.E., Berkman, L.F., Charpentier, P.A., Blazer, D.G., Albert, M.S. and Tinetti, M.E. 1995. Behavioral and psychosocial predictors of physical performance: MacArthur Studies on Successful Aging. *J. Gerontol. A. Biol. Sci. Med. Sci.*, 50A:M177–M183.
- [24] Visser, M., Pluijm, S.M.F., Stel, V.S., Bosscher, R.J. and Deeg, D.J.H. 2002. Physical activity as a determinant of change in mobility performance: The Longitudinal Aging Study Amsterdam. *J. Am. Geriatr. Soc.*, 50:1774–81.
- [25] Crespo, C.J., Keteyian, S.J., Heath, G.W. and Sempos, C.T. 1996. Leisure-time physical activity among US adults. *Arch. Intern. Med.*, 156:93–8.
- [26] Crespo, C.J., Smit, E., Andersen, R.E., Carter-Pokras, O. and Ainsworth, B.E. 2000. Race/ethnicity, social class and their relation to physical inactivity during leisure time: Results from the Third National Health and Nutrition Examination Survey, 1988–1994. *Am. J. Prev. Med.*, 18:46–53.
- [27] Ransdell, L.B. and Wells, C.L. 1998. Physical activity in urban white, African-American, and Mexican-American women. *Med. Sci. Sports Exerc.*, 30:1608–15.
- [28] Carpenter, W.H., Fonong, T., Toth, M.J. et al. 1998. Total daily energy expenditure in free-living older African-Americans and Caucasians. *Am. J. Physiol.*, 274:E96–E101.
- [29] Clark, D.O. 1995. Racial and educational differences in physical activity among older adults. *Gerontologist*, 35:472–80.
- [30] Simonsick, E.M., Guralnik, J.M. and Fried, L.P. 1999. Who walks? Factors associated with walking behavior in disabled older women with and without self-reported walking difficulty. *J. Am. Geriatr. Soc.*, 47:672–80.
- [31] Scott-Okafor, H.R., Silver, K., Parker, J. and Gardner, A.W. 2001. Lower extremity strength deficits in peripheral arterial occlusive disease patients with intermittent claudication. *Angiology*, 52:7–14.
- [32] Brown, M., Sinacore, D.R., Binder, E.F. and Kohrt, W.M. 2000. Physical and performance measures for the identification of mild to moderate frailty. *J. Gerontol. A. Biol. Sci. Med. Sci.*, 55A: M350–M355.
- [33] Simonsick, E.M., Maffeo, C.E., Rogers, S.K. et al. 1997. Methodology and feasibility of a home-based examination in disabled older women. The Women's Health and Aging Study. *J. Gerontol. A. Biol. Sci. Med. Sci.*, 52A:M264–M274.
- [34] Taylor, H.L., Jacobs, Jr, D.R., Schucker, B., Knudsen, J., Leon, A.S. and Debacker, G.J. 1978. A questionnaire for the assessment of leisure time physical activities. *J. Chronic Dis.*, 31:741–55.
- [35] Goran, M.I. and Poehlman, E.T. 1992. Total energy expenditure and energy requirements in healthy elderly persons. *Metabolism*, 41:744–53.
- [36] Folsom, A.R., Jacobs, D.R., Caspersen, C.J., Gomez-Marin, O. and Knudson, J. 1986. Test-retest reliability of the Minnesota leisure time physical activity questionnaire. *J. Chronic Dis.*, 39:505–11.
- [37] Visser, M., Harris, T.B., Langlois, J. et al. 1998. Body fat and skeletal muscle mass in relation to physical disability in very old men and women of the Framingham Heart Study. *J. Gerontol. A. Biol. Sci. Med. Sci.*, 53A:M214–M221.
- [38] Sparling, P.B. 1980. A meta-analysis of the studies comparing maximal oxygen uptake in men and women. *Res. Quarterly Exerc. Sport*, 51:542–52.