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Study of Musculoskeletal Ambulation Disability Symptom Complex (MADS) in Elderly Community Residents: a Comparison of Physical Function between the Elderly with and without Potential MADS

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Abstract. [Purpose] This study examined the physical function of elderly community-dwellers with and without potential musculoskeletal ambulation disability symptom complex (MADS), determined by the evaluation criteria for the disease. [Subjects] The subjects were 522 community-dwelling elderly. [Methods] Subjects were divided into 2 groups, with (146) and without (376) potential MADS, to compare their physical function. Evaluation of physical function was made with the following 8 items: walking speed; 10-m obstacle walk; 6-minute walking distance; hand grip strength; quadriceps muscle strength; foot grip strength; sit-ups; and sit-and-reach flexibility. [Results] The results show that the age was significantly higher and the overall limb and trunk muscle strength was markedly lower in the elderly community-dwellers with potential MADS. However, in the analysis of covariance adjusting for the age and sex, significant differences between the groups were only observed in the foot grip strength and walking ability. [Conclusion] These results suggest that a decline in foot function and walking ability is characteristic of the physical function of the elderly with potential MADS.
Key words: Elderly community-dwellers, Musculoskeletal ambulation disability symptom complex, Physical function

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INTRODUCTION

In Japan, because of the aging of society, the elderly aged 65 and over reached 20% of the total population in 2005; this was the highest percentage in the world[1]. Under such circumstances, it is necessary to adopt interventions to promote the independence of the elderly. Motor disorders, including joint diseases, falls, and fractures, are the leading causes of care dependency and a markedly decreased quality of life in the elderly[2].

For early identification and management, a new category of motor disorders was established in 2006: musculoskeletal ambulation disability symptom complex (MADS). MADS is defined as an increased risk of falls and isolation due to an age-related decline in balance and walking ability. While it is expected that early intervention would contribute to prolonged independence of the elderly[3], MADS is a recently defined disease involving diverse pathological conditions; therefore, there are few studies which have examined the characteristics of physical function common to all its primary diseases.

In consideration of this situation, this study examined the physical function of elderly community residents with and without potential MADS, determined by based on the evaluation criteria for the disease.

SUBJECTS AND METHODS

Subjects

A total of 522 (104 males and 418 females) independent elderly community-dwellers of Town A, aged 60 and over, whose cooperation was obtained every August and September during the period from 2008 to 2010, were studied. Their mean age years, height (cm), and weight (kg) were 73.1±7.3, 150.5±9.9, and 55.2±9.5, respectively. All subjects were able to access the site of the study by car, bicycle, or on foot, and were provided with an explanation of the study objectives and details, as well as ethical considerations, including

a guarantee of privacy protection and completely voluntary participation and withdrawal, in order to obtain their consent. This study was conducted with the approval of the Research Ethics Committee of Nishikyushu University.

Methods

After collecting subject attribute data, motor function assessments (standing on one foot with eyes open and TUG) were conducted. To evaluate the physical function, the following tests were conducted to measure walking ability, muscle strength, and flexibility: walking speed; 10-m obstacle walk; 6-minute walking distance ; hand grip strength; quadriceps muscle strength; foot grip strength: sit-ups; and sit-and-reach flexibility tests.

The ability to stand on one foot with eyes open was measured as directed by the New Physical Fitness Test for the Elderly published by the Ministry of Education, Culture, Sports, Science, and Technology[4]. A digital stopwatch was used for timing and the maximum time was set as 120 seconds. The time was recorded twice on each foot and the longest time was adopted. Subjects were instructed to stand without their shoes, place their arms at their sides, and look 2 m forward at the height of their eyes.

TUG was conducted using the method of Podsiadlo and colleagues[5]. The time needed to stand up from a chair, walk toward a target at a distance of 3 m, reverse direction, and return to sit on the chair again was measured using a digital stopwatch.

To measure the walking speed, subjects were instructed to walk a flat 11-m course at their maximum speed. Measurement of the middle 5 m was performed twice using a digital stopwatch, and the fastest speed was adopted[6].

Measurement of the 10-m obstacle walk also followed the New Physical Fitness Test for the Elderly published by the Ministry of Education, Culture, Sports, Science, and Technology[4]. The time needed to walk a straight 10-m course at the maximum speed while avoiding 6 sponge obstacles 20 cm high placed at intervals of 2 m was measured. Measurement was performed twice using a digital stopwatch, and the shortest time was adopted.

For the 6-minute walking distance, subjects walked around a 30-m indoor circuit as many times as possible for 6 minutes. The distance walked was recorded in meters[7].

The hand grip strength was measured using a digital dynamometer (Takei Scientific Instruments Co., Ltd.). Subjects were instructed to stand with their arms straight at their sides. Measurement was performed twice on each side, and the greatest value relative to the subject's weight was adopted.

The quadriceps muscle strength was measured using a hand-held dynamometer (an isometric muscle strength measurement device by ANIMA Corp.) in a sitting position with the knee angle at 90 degrees. Measurement was performed twice on each side, and the greatest value relative to the subject's weight was adopted.

The foot grip strength was measured using a strain gauge (YAGAMI INC.) in a sitting position with the knee angle at 90 degrees. Measurement was performed twice on each side, and the largest value was adopted. Regarding the reproducibility of values obtained with this measurement device, Murata and colleagues[8] reported an intraclass correlation coefficient of 0.953.

The sit-up test was conducted as directed by the New Physical Fitness Test for the Elderly published by the Ministry of Education, Culture, Sports, Science, and Technology[4]. Subjects were instructed to cross their arms in front of their chest while keeping the knee angle at 90 degrees in a supine position, and raise the upper body until the elbows made contact with the thighs. Their legs were firmly held by researchers during sit-ups. The number of sit-ups correctly performed within 30 seconds was recorded.

The sit-and-reach flexibility test also followed the New Physical Fitness Test for the Elderly published by the Ministry of Education, Culture, Sports, Science, and Technology[4]. Subjects were instructed to sit on the floor with their legs equally stretched out in front of them with their knees straight and their ankle joints at 90 degrees. Measurement was performed twice using a digital sit-and-reach flexibility measurement device (Takei Scientific Instruments Co., Ltd.), and the longest distance was adopted.

The subjects were divided into 2 groups, with and without potential MADS[3], based on our assessment.

The ratio of males to females was calculated using χ^2, while the age, walking speed, the time to walk 10 m while avoiding obstacles, hand grip strength, quadriceps muscle strength, foot grip strength, sit-ups, and sit-and-reach flexibility were compared using the unpaired t-test. In addition, analysis of covariance was performed considering the age and sex as covariates. SPSS17.0 J for Windows was used for these analyses, with a significance level of 5%.

RESULTS

The mean time (seconds) of standing on one foot with eyes open was 39.7±40.9, and that of TUG was 5.7±1.9. Among the 522 subjects, 146 (14 males and 132 females, 28.0%) were considered to be with and 376 (90 males and 286 females) without potential MADS.

A significant difference was observed in the male-female ratios between the groups (χ^2=13.6, $p<0.01$). The unpaired t-test showed significant differences between the groups in age ($p<0.01$), walking speed ($p<0.01$), 10-m obstacle walking time ($p<0.01$), 6-minute walking distance, hand grip strength ($p<0.01$), quadriceps muscle strength ($p<0.01$), foot grip strength ($p<0.01$), and sit-ups ($p<0.01$). Subjects with potential MADS had higher ages and lower walking ability indices and muscle strength values (Table 1). No significant differences was found for sit-and-reach flexibility. Analysis of covariance adjusting for the age and sex showed significant differences in the walking speed ($p<0.01$), 10-m obstacle walking time ($p<0.05$), 6-minute walking distance ($p<0.05$), and foot grip strength ($p<0.05$). No significant differences in the other items were found (Table 1).

DISCUSSION

In the comparison of physical function between subjects with and without potential MADS, significant differences

Table 1. Measurement values of subjects with and without potential MADS

	total (N=522)	with potential MADS (N=146)	without potential MADS (N=376)
age (years)	73.1 ± 7.3	78.0 ± 5.6	71.2 ± 7.0**
walking speed (m/sec)	1.9 ± 0.5	1.5 ± 0.5	2.1 ± 0.5** ##
10-m obstacle walk (sec)	7.5 ± 3.3	9.8 ± 4.7	6.6 ± 1.9** #
6-minute walking distance (m)	436.3 ± 111.2	342.2 ± 125.7	466.2 ± 87.3** #
grip strength (%)	45.9 ± 11.8	39.6 ± 9.0	48.4 ± 11.8**
quadriceps muscle strength (%)	40.3 ± 12.3	33.4 ± 9.9	4.0 ± 12.0**
foot grip strength (kg)	6.7 ± 3.5	4.6 ± 2.6	7.5 ± 3.5** #
sit-ups test (times)	4.5 ± 5.0	2.5 ± 3.9	5.2 ± 5.1**
sit-and-reach flexibility (cm)	36.9 ± 8.8	36.2 ± 8.8	37.2 ± 8.7

Date are expressed as means ± SD, **p<0.01=t-test, ##p<0.01, #p<0.05=analysis of covariance considering age and sex, MADS; musculoskeletal ambulation disability symptom complex

were observed in all muscle strength and walking ability indices, except for flexibility; the values were lower in subjects with than in those without potential MADS. In the analysis of covariance adjusting for the age and sex, significant differences were not observed in the hand grip strength, quadriceps muscle strength, sit-ups, or flexibility, but they were found in foot grip strength and all the walking ability indices.

As diagnostic criteria for MADS, standing on one foot with eyes open and TUG have been reported to generally reflect walking ability[5] and muscle strength[9]. In line with such findings, the values of the overall limb (hand grip, quadriceps muscle, and foot grip strength) and trunk (sit-ups) muscle strength, as well as the walking speed, 10-m obstacle walking time, and 6-minute walking distance as walking ability indices, in subjects with potential MADS were significantly lower in this study. On the other hand, no significant differences were observed in sit-and-reach flexibility between the 2 groups; however, considering that values of this test as a body flexibility index have a poor correlation with those of physical abilities, and, in fact, no significant correlation with motor abilities, such as walking speed, was found in preceding studies[10], this should not be regarded as a contradictory result.

Physical function declines with age in the elderly[11]. In this study, the age of subjects with potential MADS was markedly higher, and their walking ability and muscle strength were reduced. Further more, in the analysis of covariance adjusting for the age and sex in consideration of the finding that physical strength tends to be markedly higher in males than females[12, 13], significant differences were independently observed only in the walking speed, 10-m obstacle walking time, 6-minute walking distance, and foot grip strength. The overall limb and trunk muscle strength has been reported to be greatly affected by age and sex[11–13]. The difference in muscle strength shown by single-variable analysis in this study was apparent, suggesting the possibility that it is not a functional decline involved in MADS; however, analysis of covariance adjusting for the age and sex also showed a significant difference in foot grip strength. Mecagni and colleages[14] pointed out that a decline in foot mobility is a cause of falls, while others have reported that a weaker foot grip strength may increase the risk of falls[15]. Furthermore, the possibility that a decline in the ability to stand on one foot with eyes open, which is included in the assessment of MADS, causes falls[16], has also been reported. These findings suggest that the balance ability, such as the foot and plantar function, declines in subjects with potential MADS.

The significant differences in all walking ability indices shown by the analysis of covariance adjusting for the age and sex suggest that MADS may accurately reflect a decline in walking ability. In this respect, Berg and colleages[17] reported a strong correlation of walking speed with balance ability. The walking speed has also been reported to represent motor ability[10]. Brown and colleagues[18] reported an association between ability to avoid obstacles while walking and the risk of falls. The 6-minute walking distance has been reported to be closely associated with daily living activities[19]. Considering that MADS is defined as an increased risk of falls and isolation due to an age-related decline in balance and walking ability, the results of this study demonstrate that a decline in walking ability is the main pathological condition of the disease; therefore, follow-up studies may be necessary to continuously examine the physical function of those with and without potential MADS, while promoting fitness programs in preventive care services to enhance walking ability, and balance ability.

In this study, the overall limb and trunk muscle strength was greatly affected by age and sex, and, consequently, showed a decline in subjects with potential MADS. Furthermore, the results demonstrate a decline in foot grip strength and walking ability as physical function characteristics of MADS. However, the diagnosis of MADS was not made by physicians, and, therefore, the diagnosis may not necessarily be correct. This is a limitation of this study, and it will be necessary to confirm whether subjects with potential MADS actually have the disease in medical facilities.

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