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Research article

A Study of Changes of Physical Functions According to Changes in Cognitive Functions in Community-Dwelling Elderly People Who Participated in an Exercise Program

Noriko Kimura [1]✉, Etsuko Maeshima [1], Sayaka Tomokane [1], Akiko Ikeshima [1], Megumi Maeda [2], Masaki Takimoto [3] and Takaaki Mishima [1]

[1] Osaka University of Health and Sport Sciences, Department of Health and Sport Management, Sennan, Osaka, Japan
[2] Kishigawa rehabilitation hospital, Kinokawa, Wakayama, Japan; [3] Kyoto University of Advanced and Science, Faculty of Health and Medical Sciences, Department of Health and Sport Sciences, Kameoka, Kyoto, Japan

Abstract

Although it is known that physical function differs depending on the state of cognitive function, there are no studies that consider changes in cognitive functions when evaluating physical functions of participants before and after an exercise program. In this study, it was observed changes in cognitive function and physical functions of elderly people who participated in a community-based exercise program for 6 months, and examined changes in physical functions that took into account changes in cognitive functions. Forty-nine participants, whose cognitive and physical functions were both measured before and after the exercise program, were included in the analysis. The Japanese version of the Montreal Cognitive Assessment (MoCA-J) was used to assess participants' cognitive function and to determine whether they had mild cognitive impairment (MCI). To assess physical functions, a battery of physical tests was completed. Participants were classified into four groups (before/after; non-MCI/non-MCI, MCI/MCI, non-MCI/MCI, and MCI/non-MCI) according to the changes in cognitive functions after six months. There was no significant difference in the physical functions of the four groups before the start of the program. When changes in physical functions were examined in each group, some changes in physical functions were observed in the groups other than the non-MCI/MCI group. However, there was no significant difference in the physical functions between the four groups after the program. It was suggested that changes in physical functions of elderly people who participated in a community-based exercise program over a 6-month period were not different due to changes in cognitive functions.

Key words: Mild cognitive impairment, community-dwelling elderly people, exercise program, retrospective study, physical function.

Introduction

Recently, decline in physical functions with aging is reported to be one of the factors leading to bedridden patients, and is associated with falls, associated fractures (Grisso et al., 1991), and decline in cognitive functions (Mielke et al., 2013). This leads to concerns that it will not only increase medical and nursing care costs but also increase the burden on families. Since it has been reported that physical activities in the elderly people were related to physical (Bae et al., 2019) and cognitive functions (Suzuki et al., 2012; Colcombe and Kramer, 2003), it is an urgent issue to increase physical activities in the elderly people and to maintain and improve physical and cognitive functions.

On the other hand, it is known that physical functions differ depending on the state of cognitive functions. There is a condition called mild cognitive impairment (MCI) that is considered a precursor to dementia. It has been reported that 10-15% of patients who have MCI will develop dementia during the subsequent year (Petersen et al. 2001). MCI has been defined as follows: even when the complaint of cognitive decline is reported by the patient herself/himself or the third person, the patient has normal cognitive function overall, is independent in basic activities of daily living, and does not suffer dementia, but exhibit memory impairment that cannot be explained only by aging or educational level (Petersen et al., 2009). It has been reported that elderly people with MCI have poorer postural sway (Liu-Ambrose et al., 2008), limb coordination (Franssen et al., 1999) and function (Aggarwal et al., 2006) compared to non-MCI elderly people.

In Japan, community-based exercise classes for 3 to 6 months are widely held to maintain and improve the physical functions of the elderly people. In these classes, elderly people with various state of cognitive functions participate, but they all perform the same exercise events with the same intensity. In order to verify whether the exercise programs provided in such exercise classes are effective in maintaining and improving physical functions, it is necessary to evaluate physical functions by taking into account the state of cognitive functions at the time of participation in the exercise classes and changes in cognitive functions associated with physical activities. Nevertheless, no such study has been conducted.

Therefore, in this study, it was observed changes in cognitive function and physical functions of elderly people who participated in a community-based exercise program for 6 months, and examined changes in physical functions that took into account changes in cognitive functions.

Methods

Study design

This retrospective study aimed to investigate the characteristics and changes of physical function according to changes in cognitive function in participants of a composite exercise program called "Physical Fitness and Rejuvenation Program," which was held at Osaka University of

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Health and Sport Sciences (Kumatori-cho, Sennan-gun, Osaka prefecture).

Physical Fitness and Rejuvenation Program

The purpose of this program was to improve the health of community-dwelling elderly people who were not certified as individuals requiring nursing care. The program was held once every two weeks from May to December every year. Each session consisted of 135 minutes: 60 minutes for a lecture about staying healthy, 10 minutes for warm-up exercises such as jogging and stretching, and 65 minutes for practical exercises in various kinds of sports. Each practical exercise was conducted under the guidance of experts. The participants were encouraged to participate in all sessions as much as possible. The contents of the program held in 2017 are shown as an example in Table 1. Between sessions (2 weeks), the participants were instructed to exercise as much as possible outside of this program.

Table 1. Physical Fitness and Rejuvenation Program's contents in 2017

Session	Contents
1	Opening ceremony. Orientation Enjoyable exercise for health promotion
2	Measurement of cognitive and physical functions (before the program)
3	Lecture: aging and health Exercise: muscle strength training and stretching
4	Lecture: metabolic syndrome and its prevention Exercise: new sports
5	Aquatic exercise (only exercise)
6	Tennis (only exercise)
7	Lecture: Well-balanced diet Exercise: slow jogging
8	Lecture: Brain crisis associated with aging Exercise: Training at training room
9	Lecture: Muscle morphological changes associated with aging Exercise: Cardio-pulmonary resuscitation and automated external defibrillator
10	Lecture: Exercise and glucose metabolism in muscles Exercise: exercises in a rhythmic pace
11	Measurement of cognitive and physical functions (after the program)
12	Lecture: Bone changes associated with aging Results of the physical and cognitive function measurement. Closing ceremony

Note: this table shows the contents of the program as an example.

Participants

Study participants were selected from those who participated in the program, which was held from 2015 to 2017, for the first time and were judged to be eligible for the program based on the results of a questionnaire on disease status, measurements of blood pressure and pulse rate, and health checkup provided by the local government. Of the 159 elderly participants, 54 men were excluded. In addition, 16 participants aged below 60 years, 20 participants did not complete both physical and cognitive measurements, and 20 participants with missing data were excluded. The remaining 49 participants were included in the study (Figure 1). The present study used the Japanese version of the Montreal Cognitive Assessment (MoCA-J) to evaluate cognitive functions for classification of the participants. The participants were divided into the groups according to the presence or absence of MCI before and after the program.

This study was approved by the Ethics Committee of our institution (approval number: 17-14). The study objectives, contents, method, and planned use of the data were explained to the participants, and all provided oral and written informed consent before participating in the study.

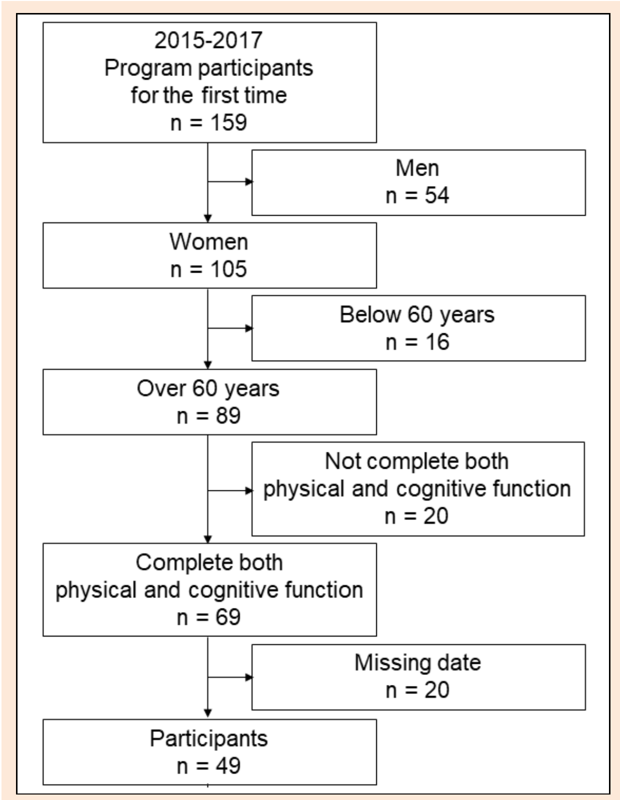

Figure 1. Flow chart of subjects.

Cognitive functions measures

Cognitive functions were evaluated at the start and upon completion (at 6 months) of the program. Hereafter, the start of the program is referred to as "before the program," and the completion of the program (at 6 months) as "after the program." MoCA-J was used for the assessment of cognitive functions. Although the Hasegawa's dementia scale-revised (Imai and Hasegawa, 1994) and the Mini Mental State Examination (MMSE) (Folstein et al., 1975) have been widely used for dementia screening, the MoCA has been increasingly used in recent years because it is quick to administer and can provide accurate screening for MCI even in the early stages (Nasreddine et al., 2005). The usefulness of the MoCA-J has also been acknowledged because MoCA-J demonstrated a sensitivity of 93.0% and a specificity of 87.0% in screening MCI (Fujiwara et al., 2010).

The MoCA-J is a multidimensional cognitive assessment tool of visuospatial/executive functions, naming, attention, language, abstraction, delayed recall, and orientation. The total score is 30, and a score of 25 or less is considered as MCI (Nasreddine et al., 2005).

Physical functions measures

Physical functions were evaluated at the start and upon completion (at 6 months) of the program. Hereafter, the start of the program is referred to as "before the program", and the completion of the program (at 6 months) as "after the program". The following 10 tests were performed to assess the physical function objectively and multidimensionally: one-leg stand with eyes open as an assessment of balance ability of lower limbs; sit and reach as an assessment of flexibility; grip strength as an assessment of muscle strength of upper limbs; vertical jump as an assessment of jumping power of lower limbs; functional reach test as an assessment of postural balance ability; stepping as an assessment of agility ability, 30-second chair stand (CS-30), sit-ups, and leg strength as assessments of muscle strength and endurance of lower limbs, and 10-meter normal walking and 10-meter fast walking as assessments of walking ability. We used these tests because they were feasible to administer and had been used in previous studies to measure physical function of elderly people in Japan (Ministry of Education, 2010; Kimura et al., 2012; Yamada et al., 2010). The measurement of physical function was performed by well-trained examiners. For measurements of walking ability, smaller values indicate better performance, while for the other measures, greater values indicate better performance in physical function.

One-leg stand with eyes open

In this test of balance, participants were instructed to stand on one preferred leg with eyes open while raising the other leg approximately 5 centimeters (cm) from the floor and placing their hands on their waist, and one-leg standing time was measured. The measurement was completed when the raised leg touched the other leg or the floor, when the supporting leg moved, or when the hands fell from the waist. The maximum amount of time that the measurement can be taken for was 180 seconds (s). Time was measured using a digital stopwatch.

Sit and reach

Measurements were made using a digital long-sitting body-bending tester (T.K.K.5112, Takei Instruments Co., Ltd, Niigata, Japan). Participants sat in a long-sitting position with their back against the wall. They were asked to bend forward maximally with their hands about shoulder-width apart, without bending the elbows. Measurement was performed twice, and the higher value of the two measurements was used for the analysis.

Grip strength

The measurement of hand grip strength was made using a Smedley-type hand dynamometer (Grip-D T.K.K.5401, Takei Instruments Co., Ltd, Niigata, Japan). Measurement was performed twice on both the right and left sides alternatively. The higher values of the two measurements were selected, and their average was used for the analysis.

Vertical jump

The measurement was made using a digital vertical jump measuring instrument (Jump-MD T.K.K.5406, Takei Instruments Co., Ltd, Niigata, Japan). Participants were asked to wear the device on the waist and jump from the standing position without using the upper extremities to provide propulsive forces. Measurement was performed twice, and the higher value of the two measurements was used for the analysis.

Functional reach test

The measurement was made using a digital functional reach test measuring instrument (T.K.K.5802, Takei Instruments Co., Ltd, Niigata, Japan). The participants stood with their side facing the wall with legs about shoulder-width apart and shoulders flexed at an angle of 90 degrees. They were instructed to bend forward as far as possible, and the maximum distance was measured. Measurement was performed twice, and the higher value of the two measurements was used for the analysis.

Stepping

The participants sat on the front edge of a chair and held both sides of the chair with their hands for stability. The feet were placed in two parallel lines 30 cm apart. They were instructed to lift their legs, touch the floor outside the lines, and then quickly return to the original position without touching the lines, as quickly as possible, for 20 s. The time (20 s) was measured using a digital stopwatch. The number of touches on the floor inside the two lines was counted.

30-second chair stand (CS-30)

The participants sat on the front edge of a chair, with their arms crossed in front of the chest. They were instructed to stand up (to the maximum knee extension, according to the body sense) and sit down as quickly as possible for 30 s. The time (30 s) was measured using a digital stopwatch. The total number of stand-ups was counted.

Sit-ups

Participants were asked to lay in a supine position with their arms crossed in front of the chest and knees flexed at an angle of 90 degrees; the leg position was maintained by an assistant. They were instructed to sit up from the supine position (to the extent that their elbow touched the thighs) and return to the original position, as quickly as possible, for 30 s. The time (30 s) was measured using a digital stopwatch. The total number of sit-ups was recorded.

Leg strength

The measurement of leg strength was made using a single-leg muscle strength measuring chair (T.K.K.5715, Tension Meter D, K.K.5710e, Takei Instruments Co., Niigata, Japan). The participants were asked to sit on the measuring chair. After the brace of Tension Meter D was placed on the ankle joint of a leg, they were instructed to extend the knee joint gradually with maximum effort. The maximum knee extension strength was measured for each leg. The average of the two measurements was used for the analysis.

10-meter normal walking and 10-meter fast walking

The time needed to walk 10 meters (m) at a normal speed (normal walking) and at maximum speed (fast walking) was measured. The time of walking was measured using a digital stopwatch.

Other measurements

Information on age was collected from the questionnaire. Body weight (kg) and height (cm) were measured using conventional scales, and body mass index (BMI) was calculated by dividing the body weight by height (m) squared (kg/m^2). These indices were measured before and after the program. Table 2 shows the body composition of participants at baseline. In addition, the participation rate in the program was calculated.

Table 2. **Body composition of the present participants (n = 49).**

Age (years)	67.2 ± 3.9
Height (m)	1.54 ± 0.04
Weight (kg)	53.0 ± 6.2
BMI (kg/m^2)	22.4 ± 2.6

Variables are represented as mean ± SD. BMI: body mass index.

Statistical analysis

Comparisons of age, physical function (before and after the program), and participation rate in the program among the groups were performed using the Kruskal Wallis H test. Comparison of physical function before and after the program in each group was performed using the Wilcoxon signed rank sum test. Statistical significance was set at $p < 0.05$. Statistical analysis was performed using SPSS Statistics version 21 (IBM Japan, Japan).

Results

The changes of cognitive functions

The participants with MCI before the program were 35 participants (71.4% of all participants), and those with non-MCI before the program were 14 participants (28.6% of all participants). After the program, the participants with MCI were 25 participants (51.0% of all participants), and those with non-MCI were 24 participants (49.0% of all participants). The participants were grouped according to their MoCA-J scores before and after the program, and were classified into the following four groups. Participants were classified in the MCI/MCI group (MM group; 21 participants; 42.9%), the MCI/non-MCI group (Mn group; 14 participants; 28.6%), the non-MCI/MCI group (nM group; 4 participants; 8.2%), and the non-MCI/non-MCI group (nn group; 10 participants; 20.4%) (Table 3).

Table 3. **The changes of cognitive functions (n = 49).**

BEFORE n (%)	AFTER n (%)
MCI 35 (71.4)	MM group 21 (42.9) Mn group 14 (28.6)
non-MCI 14 (28.6)	nM group 4 (8.2) nn group 10 (20.4)

Percentage of participants classified into each group by cognitive function. MCI: mild cognitive impairment; MM group: the MCI/MCI group; Mn group: the MCI/non-MCI group; nM group: the non-MCI/MCI group; nn group: the non-MCI/non-MCI group

Age and participation rate in each group

The median (range) age of each group before the program was 69 (62-74) years for the MM group, 65.5 (60-73) years for the Mn group, 70 (64-73) years for the nM group, and 65 (61-72) years for the nn group, with no significant differences among the groups. In addition, the median participation rate was 90% or more in any of the groups, with no significant differences among the groups (Table 4).

Physical functions in each group

Comparisons of physical function among the four groups showed no significant differences both before and after the program (Table 4).

Comparison of physical function before and after the program in each group showed that the MM group had significant improvement in CS-30 ($p < 0.01$), sit-ups ($p = 0.024$), leg strength ($p = 0.021$), and 10-meter fast walking ($p = 0.044$); and the Mn group had significant improvement in sit and reach ($p = 0.013$), CS-30 ($p = 0.012$), 10-meter normal walking ($p < 0.01$), and 10-meter fast walking ($p = 0.033$). The nn group had significant improvement in CS-30 ($p = 0.028$) but significant decline in vertical jump ($p = 0.028$). The nM group had no significant differences before and after the program (Table 5).

Table 5. **Comparison of physical function before and after the program in each group.**

	MM group *P*	Mn group *P*	nM group *P*	nn group *P*
One-leg stand with eyes open (s)	n.s.	n.s.	n.s.	n.s.
Sit and reach (cm)	n.s.	0.013	n.s.	n.s.
Grip strength (kg)	n.s.	n.s.	n.s.	n.s.
Vertical jump (cm)	n.s.	n.s.	n.s.	0.038
Functional reach test (cm)	n.s.	n.s.	n.s.	n.s.
Stepping (count)	n.s.	n.s.	n.s.	n.s.
CS-30 (count)	0.001	0.012	n.s.	0.028
Sit-ups (count)	0.024	n.s.	n.s.	n.s.
Leg strength (kg)	0.021	n.s.	n.s.	n.s.
10-meter normal walking (s)	n.s.	0.006	n.s.	n.s.
10-meter fast walking (s)	0.044	0.033	n.s.	n.s.

Variables are represented as median (min-max: range). CS-30: 30-second chair stand; MM group: the MCI/MCI group; Mn group: the MCI/non-MCI group; nM group: the non-MCI/MCI group; nn group: the non-MCI/non-MCI group; n.s.: not significant. Comparison of physical function before and after the program in each group was performed using the Wilcoxon signed rank sum test. Statistical significance was set at $p < 0.05$.

Table 4. Comparisons of age, participation rate and physical functions among the four groups

		MM group (n = 21)		Mn group (n = 14)		nM group (n = 4)		nn group (n = 10)		*P*
		Median (min-MAX)	Mean ± SD	Median (min-MAX)	Mean ± SD	Median (min-MAX)	Mean ± SD	Median (min-MAX)	Mean ± SD	
BEFORE	Participation rate (%)	100 (63.6-100)	94.8 ± 9.8	90.9 (72.7-100)	89.7 ± 8.6	91.7 (81.8-100)	91.3 ± 7.4	91.7 (66.7-100)	89.5 ± 12.1	n.s.
	Age* (y)	69.0 (62.0-74.0)	68.6 ± 3.5	65.5 (60.0-73.0)	66.1 ± 3.7	70.0 (64.0-73.0)	69.3 ± 4.1	65.0 (61.0-72.0)	65.3 ± 4.2	n.s.
	One-leg stand with eyes open (s)	66.0 (8.9-180.0)	83.7 ± 56.9	75.5 (26.0-180.0)	93.8 ± 49.3	110.5 (7.6-121.0)	87.4 ± 54.1	45.0 (20.0-137.0)	53.3 ± 33.0	n.s.
	Sit and reach (cm)	44.5 (24.5-54.0)	41.9 ± 7.5	33.3 (22.0-46.0)	35.0 ± 8.5	39.8 (30.0-41.5)	37.8 ± 5.3	39.3 (17.0-52.5)	36.8 ± 12.4	n.s.
	Grip strength (kg)	24.3 (17.8-32.4)	25.1 ± 4.3	26.1 (15.0-31.5)	25.3 ± 4.1	23.4 (21.3-26.5)	23.6 ± 2.1	25.3 (19.5-28.3)	24.8 ± 2.9	n.s.
	Vertical jump (cm)	23.0 (17.0-40.0)	24.6 ± 5.8	25.0 (18.0-33.0)	25.1 ± 3.8	24.0 (19.0-30.0)	24.3 ± 4.8	28.0 (19.0-40.0)	28.2 ± 7.0	n.s.
	Functional reach test (cm)	42.0 (23.0-63.5)	42.0 ± 10.0	40.5 (30.0-65.0)	41.0 ± 9.1	42.8 (38.0-46.7)	42.6 ± 4.0	42.0 (30.0-50.0)	40.9 ± 5.8	n.s.
	Stepping (count)	32.0 (19.0-70.0)	34.8 ± 11.1	37.5 (23.0-60.0)	38.0 ± 10.8	39.5 (32.0-40.0)	37.8 ± 3.9	33.5 (15.0-61.0)	34.6 ± 12.1	n.s.
	CS-30 (count)	21.0 (14.0-37.0)	22.2 ± 5.6	22.5 (14.0-41.0)	23.9 ± 8.4	27.5 (16.0-31.0)	25.5 ± 6.7	23.0 (14.0-34.0)	23.3 ± 6.9	n.s.
	Sit-ups (count)	12.0 (0.0-20.0)	10.5 ± 5.5	8.0 (0.0-33.0)	8.8 ± 8.7	9.0 (6.0-15.0)	9.8 ± 3.9	10.5 (3.0-17.0)	11.2 ± 4.7	n.s.
	Leg strength (kg)	27.7 (12.3-38.6)	27.7 ± 7.0	29.7 (16.3-41.7)	29.6 ± 6.9	21.2 (15.0-23.5)	20.2 ± 4.1	32.8 (20.9-53.0)	33.9 ± 11.0	n.s.
	10-meter normal walking (s)	6.8 (5.2-9.8)	7.0 ± 1.3	7.5 (6.1-9.0)	7.6 ± 0.9	6.4 (6.0-6.6)	6.3 ± 0.2	7.5 (6.1-12.0)	7.9 ± 1.6	n.s.
	10-meter fast walking (s)	5.0 (3.6-7.4)	5.2 ± 1.0	5.1 (3.7-7.8)	5.3 ± 1.0	5.4 (5.0-5.9)	5.4 ± 0.5	5.3 (3.6-6.1)	5.2 ± 0.7	n.s.
AFTER	One-leg stand with eyes open (s)	75.0 (5.0-180.0)	80.8 ± 48.0	82.4 (11.0-180.0)	96.9 ± 65.4	81.0 (45.0-180.0)	96.8 ± 60.3	62.0 (30.0-180.0)	99.8 ± 69.8	n.s.
	Sit and reach (cm)	42.5 (20.0-56.0)	42.4 ± 8.9	38.5 (24.5-53.5)	39.1 ± 10.2	45.3 (43.0-51.0)	46.1 ± 3.5	38.8 (30.0-55.5)	39.6 ± 7.3	n.s.
	Grip strength (kg)	25.3 (17.6-31.6)	24.8 ± 3.8	27.3 (17.4-31.6)	25.8 ± 4.5	25.1 (19.5-27.1)	24.2 ± 3.3	26.3 (20.0-29.3)	25.4 ± 3.0	n.s.
	Vertical jump (cm)	24.0 (18.0-43.0)	24.7 ± 5.4	26.0 (16.0-32.0)	25.3 ± 4.6	26.5 (24.0-30.0)	26.8 ± 2.5	24.5 (15.0-34.0)	24.6 ± 5.4	n.s.
	Functional reach test (cm)	40.0 (21.0-55.0)	40.3 ± 8.0	43.0 (35.0-60.0)	43.5 ± 5.9	44.0 (28.0-51.5)	41.9 ± 11.0	38.8 (35.0-48.0)	39.4 ± 4.3	n.s.
	Stepping (count)	36.0 (27.0-46.0)	36.0 ± 4.7	36.0 (28.0-56.0)	36.7 ± 7.4	39.0 (32.0-43.0)	38.3 ± 4.6	36.5 (31.0-44.0)	36.4 ± 4.6	n.s.
	CS-30 (count)	28.0 (15.0-41.0)	27.3 ± 6.2	31.5 (17.0-37.0)	29.1 ± 7.8	29.5 (20.0-39.0)	29.5 ± 7.9	28.5 (16.0-43.0)	28.7 ± 6.9	n.s.
	Sit-ups (count)	14.0 (0.0-26.0)	13.4 ± 6.9	10.0 (0.0-33.0)	11.4 ± 8.2	9.0 (6.0-10.0)	8.5 ± 1.9	10.5 (0.0-20.0)	9.9 ± 7.8	n.s.
	Leg strength (kg)	31.7 (18.1-49.4)	31.4 ± 8.0	31.7 (19.5-45.2)	31.8 ± 8.4	26.4 (21.8-29.9)	26.1 ± 4.0	29.4 (23.8-59.2)	32.7 ± 10.6	n.s.
	10-meter normal walking (s)	6.3 (4.8-9.0)	6.6 ± 1.2	6.8 (4.9-8.3)	6.6 ± 0.9	5.6 (5.2-5.9)	5.6 ± 0.3	6.3 (4.8-9.1)	6.8 ± 1.4	n.s.
	10-meter fast walking (s)	4.7 (3.2-6.0)	4.8 ± 0.6	5.1 (3.6-5.6)	4.8 ± 0.7	4.6 (4.2-5.3)	4.7 ± 0.6	5.0 (4.3-5.7)	5.0 ± 0.5	n.s.

Variables are represented as median (min-max: range) or mean ± SD. * Age of subjects before the program. CS-30: 30-second chair stand; MM group: the MCI/MCI group; Mn group: the MCI/non-MCI group; nM group: the non-MCI/MCI group; nn group: the non-MCI/non-MCI group; n.s.: not significant. Comparisons of age, participation rate in the program and physical functions among the four groups were performed using the Kruskal Wallis H test. Statistical significance was set at $p < 0.05$.

Discussion

In this study, it was observed changes in cognitive functions and physical functions of elderly people who participated in a community-based exercise program for 6 months, and examined changes in physical functions that took into account changes in cognitive functions.

After 6 months, the cognitive functions showed improvement, decrease, and no change. When changes in physical functions were examined in light of these changes in cognitive functions, the results showed no significant differences in physical function both before and after the program among the groups classified according to the presence or absence of MCI before and after the program. In addition, comparison of physical function before and after the program in each group showed maintenance or improvement of physical function except for vertical jump in the nn group. These results suggest that changes in cognitive function may not be related to the characteristics and changes of physical function after the program.

This study differs from previous studies in that it investigated the characteristics and changes of physical function according to changes in cognitive function. Both men and women were included in many previous studies investigating the relationship between cognitive and physical function in the elderly (Franssen et al., 1999; Aggarwal et al., 2006). However, some studies suggest that there is a gender difference in cognitive function (Hebert et al., 2003; Roberts et al., 2012). In addition, it is evident that there is a gender difference in physical function. This study therefore included only women.

The participants in this study were elderly women aged 60 years or older, and there were no significant differences in physical function both before and after the program among the groups classified according to changes in cognitive function; that is, there were no differences in characteristics among the groups. However, a previous study reported that MCI patients had lower physical function compared to individuals with normal cognitive function (Liu-Ambrose et al, 2008). Physical functions in our participants were similar to that of the participants of similar age in previous studies regardless of the presence or absence of MCI (Japan Sport Agency,2019; Kimura et al., 2012). In addition, physical function of the MM group, the Mn group, and the nM group was mostly higher than that of elderly women with MCI (Narazaki et al, 2014). For example, the mean grip strength in our study was similar to that (25.41 kg) of the same age group reported by the Japan Sports Agency (2019) and that (23.1 kg) of the same age group reported by Kimura et al. (2012) (Table 4). In addition, the mean leg strength of each group in our study was mostly higher than that (24.1 kg) reported by a previous study of elderly women with MCI (Narazaki et al., 2014) (Table 4). It is reported that the effect of physical exercise is associated with the level of physical function at baseline (Lam et al., 2018). It was assumed that in the present study, the effect of physical exercise was similar among the groups because the participants had high levels of physical function at baseline regardless of the presence or absence of MCI. We therefore considered that there were no significant differences in physical function both before and after the program among the groups.

Comparisons before and after the program showed that the MM group had significant improvement in CS-30, sit-ups, leg strength, and 10-meter fast walking; the Mn group had significant improvement in sit and reach, CS-30, 10-meter normal walking, and 10-meter fast walking; and the nn group had significant improvement in CS-30 but significant decrease in vertical jump. In the nM group, physical function was maintained. A previous study investigating the relationship between cognitive and physical function showed that the cognitive function score (by the Mini-Mental State Examination) was significantly and negatively correlated with the leg function score (by Timed Up & Go Test), suggesting the importance of prescription of exercise according to cognitive status (Uemura et al., 2013). However, in this study, we demonstrated that the physical function was maintained or improved by the community-based group exercise program for community residents in which an individualized planning considering the cognitive and physical status was difficult. Nevertheless, considering the significant decrease in vertical jump in the nn group in our study and the results of Uemura et al.'s study (2013), consideration of cognitive status or more elaborated approach is needed to further improve physical function.

Limitations

In this study, there was no control group because this exercise program was conducted in cooperation with the local government for the purpose of health promotion of local residents. Therefore, careful attention is needed to interpret the results. This is not an interventional study; this is a retrospective study evaluating the changes in physical function according to changes in cognitive function in elderly women who participated in an exercise program.

In addition, the participants were recruited from community-dwelling elderly women who participated in the exercise program; it was difficult to match the number of participants in the subgroups classified according to cognitive function level. The results of this study suggest the need for considering the level of physical function of participants at baseline; therefore, future studies need to quantify the amounts of physical activity and exercise in daily life. Future studies should also include a larger sample size and a control group in order to create a more effective exercise program that can improve physical function of community-dwelling elderly people with various levels of cognitive function.

Conclusion

It was suggested that changes in physical functions of elderly people who participated in a community-based exercise program over a 6-month period were not different due to changes in cognitive functions.

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Key points

- Exercise programs are widely practiced, but there are no reports that examine changes in physical functions that take into account changes in cognitive functions.
- It was observed changes in cognitive function and physical functions of elderly people who participated in a community-based exercise program for 6 months, and examined changes in physical functions that took into account changes in cognitive function.
- It was clear that changes in cognitive functions made no difference to changes in physical functions in the community-dwelling elderly people who participated in the 6-month exercise program.

AUTHOR BIOGRAPHY

Noriko KIMURA
Employment
Research staff of Osaka University of Health and Sport Sciences, Department of Health and Sport Management, Sennan, Osaka, Japan
Degree
MSc
Research interests
Physical fitness, Muscle physiology
E-mail: kimura.academic@gmail.com

Etsuko MAESHIMA
Employment
Professor of Osaka University of Health and Sport Sciences, Department of Health and Sport Management, Sennan, Osaka, Japan
Degree
Ph.D
Research interests
Sports medicine
E-mail: etsukom@ouhs.ac.jp

Sayaka TOMOKANE
Employment
Lecturer of Osaka University of Health and Sport Sciences, Department of Health and Sport Management, Sennan, Osaka, Japan
Degree
MSc
Research interests
Health promotion, Physical fitness
E-mail: sayakat@ouhs.ac.jp

Akiko IKESHIMA
Employment
Professor of Osaka University of Health and Sport Sciences, Department of Health and Sport Management, Sennan, Osaka, Japan
Degree
MSc
Research interests
Recreation, Health promotion, Care prevention
E-mail: ikeshima@ouhs.ac.jp

Megumi MAEDA
Employment
Health fitness programmer of Kishigawa rehabilitation hospital, Kinokawa, Wakayama, Japan
Degree
MSc
Research interests
Exercise Nutrition
E-mail: megu_0163@yahoo.co.jp

Masaki TAKIMOTO
Employment
Lecturer (full time) of Kyoto University of Advanced and Science, Faculty of Health and Medical Sciences, Department of Health and Sport Sciences, Kameoka, Kyoto, Japan
Degree
Ph.D.
Research interests
Exercise physiology
E-mail: takimoto.masaki@kuas.ac.jp

Takaaki MISHIMA
Employment
Professor of Osaka University of Health and Sport Sciences, Department of Health and Sport Management, Sennan, Osaka, Japan
Degree
Ph.D.
Research interests
Sports physiology, Growth and development
E-mail: t-mishima@ouhs.ac.jp

✉ **Noriko Kimura**
Osaka University of Health and Sport Sciences, Department of Health and Sport Management, 1-1 Asashirodai, Kumatori-cho, Sennan-gun, Osaka 590-0496, Japan.