Table 4 Multivariate-adjusted odds ratios and 95% confidence intervals for frequency and the conference members according to the indication for tube feeding and interventions for dysphagia before using tube feeding

	Conference				
	Non	Occasional		Every time	
		Participating occupation		Participating occupation	
		Few	Multidisciplinary	Few	Multidisciplinary
		OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Is the following disorder an indication for TF?					
Head injury or facial trauma	Ref	1.02 (0.55–1.89)	1.15 (0.52–2.57)	0.80 (0.36–1.78)	1.52 (0.62–3.77)
Oropharyngeal malignancy	Ref	0.96 (0.56–1.66)	0.78 (0.41–1.52)	1.05 (0.48–2.31)	1.02 (0.48–2.16)
Neurological disorder	Ref	0.72 (0.34–1.52)	0.56 (0.23–1.34)	1.69 (0.46–6.16)	1.17 (0.39–3.53)
Stroke	Ref	1.41 (0.68–2.90)	1.84 (0.66–5.13)	2.35 (0.68–8.15)	4.03 (0.90–18.05)
Dementia	Ref	0.83 (0.54–1.28)	0.82 (0.48–1.42)	1.86 (1.00–3.44)	1.01 (0.56–1.83)
Aspiration-prone frail elderly without comorbidity	Ref	0.99 (0.63–1.55)	1.23 (0.69–2.19)	1.31 (0.68–2.52)	0.80 (0.44–1.46)
Malnutrition in frail elderly without comorbidity	Ref	0.77 (0.49–1.22)	0.98 (0.56–1.74)	1.30 (0.70–2.42)	1.18 (0.64–2.18)
How long does a patient need to survive after PEG placement? ≧12 weeks†	Ref	0.85 (0.50–1.43)	0.89 (0.46–1.74)	0.80 (0.39–1.63)	1.44 (0.64–3.21)
Intervention for swallowing disorder before using TF					
No. intervention items, ≧ 6 items‡	Ref	2.07 (1.33–3.20)	3.24 (1.81–5.78)	2.60 (1.39–4.85)	8.71 (3.99–19.00)
Consultation					
To otolaryngologist	Ref	1.13 (0.72–1.77)	1.36 (0.78–2.38)	0.94 (0.49–1.80)	1.48 (0.80–2.72)
To speech therapist	Ref	1.51 (0.93–2.46)	4.57 (2.52–8.29)	2.47 (1.28–4.76)	3.82 (2.01–7.27)
To certified nurse of dysphagia nursing	Ref	1.18 (0.65–2.14)	2.16 (1.11–4.23)	1.65 (0.76–3.61)	4.75 (2.43–9.32)
Test					
Repetitive saliva swallowing test	Ref	1.62 (0.98–2.66)	3.89 (2.16–6.99)	3.91 (2.05–7.44)	4.48 (2.37–8.46)
Water swallowing test	Ref	2.08 (1.32–3.28)	1.63 (0.93–2.87)	1.82 (0.96–3.44)	2.95 (1.49–5.88)
Video endoscopy	Ref	1.53 (0.83–2.82)	1.30 (0.59–2.86)	0.97 (0.37–2.53)	2.89 (1.37–6.09)
Video fluorography	Ref	1.62 (1.03–2.56)	2.08 (1.19–3.66)	3.07 (1.64–5.76)	2.28 (1.23–4.22)
Practice and education					
Oral ice-massage	Ref	1.19 (0.67–2.10)	2.19 (1.16–4.14)	2.34 (1.14–4.79)	3.59 (1.82–7.06)
Swallowing exercise	Ref	1.81 (0.97–3.39)	3.47 (1.74–6.91)	4.86 (2.34–10.09)	6.63 (3.27–13.45)
Vocalization exercise	Ref	1.55 (0.71–3.41)	2.96 (1.28–6.83)	2.70 (1.04–7.00)	6.84 (3.02–15.50)
Using semi-solid and liquid foods	Ref	1.83 (1.13–2.96)	2.12 (1.11–4.06)	1.71 (0.86–3.38)	5.96 (2.24–15.84)
Thickening agent	Ref	1.26 (0.73–2.21)	1.93 (0.85–4.39)	1.18 (0.54–2.59)	4.68 (1.36–16.12)
Positioning	Ref	1.46 (0.94–2.26)	2.36 (1.29–4.31)	1.75 (0.93–3.30)	7.22 (2.94–17.71)
Appropriate approach for swallowing	Ref	2.48 (1.59–3.88)	2.82 (1.62–4.92)	2.13 (1.15–3.95)	5.60 (2.94–10.65)
Ways to coping when the aspiration	Ref	1.48 (0.95–2.29)	2.86 (1.63–5.01)	1.24 (0.67–2.29)	5.31 (2.69–10.48)

Dependent variables: the indication for tube feeding and interventions for dysphagia before introducing tube feeding. Independent variables: frequency and the conference members (ref, non conference; 1, occasional and less than five different health-care professionals; 2, occasional and ≧5 different health care professionals; 3, every time and less than five different health-care professionals; 4, every time and ≧5 different health-care professional. Adjusted for sex, place of employment and clinical experience. †The period expected to survive after PEG was divided into two groups. (1: ≧12 weeks, 0: <12 weeks). ‡Number of intervention items were divided into two groups, which was used median value into 15 items. (1: ≧6 items, 0: <6 items). CI, confidence interval; OR, odds ratio; TF, Tube Feeding.

in patients with stroke and oropharynegeal malignancy was associated with better prognosis; therefore PEG placement is recommended for these disorders by the European guideline.[20] We did not investigate how long PEG is placed in each condition. Thus, knowledge of geriatricians for tube feeding or PEG placement was not sufficiently explored in the present study; however, a period of PEG placement should be considered in each condition.

In Japan, requests for PEG to facilitate care are prevalent, because the staff in nursing homes tend to prefer PEG to time-consuming oral feeding. A multicenter study in the USA showed that feeding tube insertion is independently associated with both clinical characteristics of residents and fiscal, organizational and demographic features of nursing homes.[4] Therefore, these situations might have affected the decision making of geriatricians for tube feeding. Unfortunately, we did not include the question whether or not the request from nursing homes might have affected the decision making for tube feeding in dementia patients. Therefore, we should ask this question next time.

Regarding interventions for swallowing disorder, the mean number of interventions for swallowing disorder before introducing tube feeding was six items, which are not so many. Among the 15 items of interventions before introducing tube feeding, over 70% of the geriatricians answered that "Thickening agent" and "Using semi-solid and liquid foods" were afforded to patients with swallowing disorder. In contrast, consultation with other specialists was not frequently carried out, and care to improve swallowing dysfunction, such as "oral ice-massage," "swallowing exercise" and "vocalization exercise" was not usually carried out either. Therefore, from these data, we think that more interventions would be necessary to care for patients with dysphagia by consulting specialists and multidisciplinary approach.

It is interesting to note the relationship between multidisciplinary conference and knowledge and practice for tube feeding for the elderly. In the present study, we showed that those who have a multidisciplinary team conference for a patient indicated for tube feeding tended to carry out more "interventions for dysphagia before tube feeding" compared with the reference group after multivariate adjustment. Furthermore, the data showed that geriatricians who organize a conference with different health-care professionals carried out more interventions for dysphagia before tube feeding, irrespective of the frequencies of conference. The present study also showed that although there were no differences in the number of conference members and interventions between the geriatricians working in an acute hospital and those in a clinic before introducing tube feeding, the percentage of geriatricians who organized a multidisciplinary conference before introducing tube feeding was higher in the hospital than in the clinic. Therefore, the characteristics of facilities, not doctors themselves, might have affected this outcome. A previous study reported that multidisciplinary CGA is effective for the care of frail older persons admitted to the hospital, because evaluation and management by a multidisciplinary team during hospitalization documented a lower rate of institutionalization after 1 year.[14] Furthermore, decision making for treatment strategy should be discussed in a multidisciplinary team. The multidisciplinary conference would provide a better answer for each elderly patient who requires tube feeding, because they tend to have a complicated background.

Several potential limitations should be considered when interpreting these results. First, a cross-sectional study does not prove any causal relationship. Second, the practice rate of tube feeding in geriatricians was not clearly determined, because the present study was carried out by self-administered questionnaires. Third, the subjects were limited to geriatricians certified by the Japan Geriatrics Society, and also the response rate was not so high. Therefore, selection bias might have occurred. Finally, we did not investigate the number of beds in their place of employment; therefore these results were not completely adjusted by hospital size.

In conclusion, the present data showed that more than half of the board-certified geriatricians consider that the purpose of tube feeding is to improve the general condition or to prevent complications in the elderly with eating problems. Furthermore, regardless of their clinical experience, approximately 40% of the Japanese geriatricians consider that demented elderly with loss of appetite or apraxia for eating should be on tube feeding. At this moment, there is no consensus among Japanese geriatricians about tube feeding for advanced demented people, and hence the guideline should be established for tube feeding in the elderly. Furthermore, a multidisciplinary team approach is expected to find a better answer for each elderly patient with eating difficulty.

Acknowledgments

We thank all geriatricians in Japan for their kind help and advice during the present research. We also thank Priscila Yukari Sewo Sampaio for critical reading of our manuscript. This study was supported by a Grant-in-Aid (H22-Tyojyu-009) from the Ministry of Health, Labour and Welfare, Japan.

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Geriatr Gerontol Int 2011

ORIGINAL ARTICLE

Complex obstacle negotiation exercise can prevent falls in community-dwelling elderly Japanese aged 75 years and older

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Objectives: The aim of the present study was to evaluate whether a complex course obstacle negotiation exercise (CC), a 24-week exercise program, can reduce falls and fractures in older adults, as compared with a simple course obstacle negotiation exercise (SC).

Methods: This trial was carried out on older adults, aged 75 years and above in Japan. In total, 157 participants were randomized into the CC group ($n = 78$) and the SC group ($n = 79$). Participants were enrolled in the exercise class using the CC program or the SC program for 24 weeks. The outcome measure was the number of falls and fracture rates in CC and SC groups for 12 months after the completion of the 24-week exercise class.

Results: Two participants (2.8%) in the CC group and 19 (26.0%) in the SC group experienced falls during 12 months. During the 12-month follow-up period after the intervention, the incidence rate ratio (IRR) of falls in the SC group against the CC group was 9.37 (95% CI = 2.26–38.77). One participant (1.4%) in the CC group and eight (10.9%) in the SC group had experienced fractures during 12 months after the exercise class. The IRR of fractures in the SC group compared with the CC group was 7.89 (95% CI = 1.01–61.49).

Conclusions: The results of the present trial show that the participants who received individualized obstacle avoidance training under complex tasks combined with a traditional intervention had a lower incidence rate of falls and fractures during the 12 months after the intervention. **Geriatr Gerontol Int 2011; ••: ••–••.**

Keywords: fall prevention, obstacle negotiation exercise, older adults, randomized controlled trial.

Introduction

Falls are relatively common events in older people. One-third of community-dwelling people, aged 65 years and older, and up to 50% of those aged 80 years and older experience a fall each year.[1,2] A previous study also reported that in community-dwelling elderly individuals, over 50% of the falls are a result of trips and slips that usually occur during walking.[3] In many of these cases, there is an external factor, such as an obstacle, that provokes and contributes to the fall.[4] In addition, the incidence of osteoporotic fractures is reported to increase with age,[5] and more than 50% of all fragility fractures in the community arise in women aged 75 years and older.[6] A recent systematic review of fall prevention programs has convincingly shown that exercise interventions are effective for reducing the risk of

Accepted for publication 6 November 2011.

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doi: 10.1111/j.1447-0594.2011.00794.x

falls and fall injuries.[7,8] However, the kind of exercise intervention most effective for fall prevention is not fully addressed.

Concurrent cognitive or motor tasks, such as talking or carrying objects, are crucial for mobility in daily life. Because of the increasingly recognized role of cognition in postural control and gait, many researchers have used complex task paradigms incorporating a concurrent cognitive task to improve their studies investigating fall risk.[9] Changes in performance during multitasking are significantly associated with an increased risk for falls in older adults.[9] The ability to modulate attention might also play an important role in the acquisition of complex task coordination skills. Therefore, we developed a trail walking exercise (TWE), in which a person walks from numbered flags in either an ascending or descending order, to evaluate cognitive and motor function simultaneously.[10] Our previous randomized controlled trial (RCT) showed that TWE has the benefit of decreasing the incidence of falls in community-dwelling elderly adults.

In everyday life, when walking in a challenging and distracting environment, older people might have to avoid ground level obstacles when their attention is divided. In this instance, obstacle-avoidance performance is likely to be further impaired, as shown by most multitask research among older adults.[11–13] In addition, Jasmine *et al.* reported that when their attention is divided, older people negotiate obstacles more slowly and contact more obstacles.[14] Therefore, in the present study, we added obstacles to the area of TWE (complex course obstacle negotiation) to mimic a "real world" walking environment with a high fall risk.

The present RCT examined the effect of fall and fall-related fracture prevention programs on attention demands of obstacles during walking under complex task conditions in community-dwelling elderly Japanese adults aged 75 years and older. The aim of the present study was to evaluate whether the complex course obstacle negotiation exercise (CC), a new 24-week exercise program, would be effective in reducing falls and fall-related fractures in community-dwelling older adults. We hypothesized that complex task walking is improved to a greater extent with the CC program than with the simple course obstacle negotiation exercise (SC). From these results, we can assume that the CC program is more effective in preventing falls and fall-related fractures than is the SC program.

Methods

Participants

Participants were recruited using an advertisement in the local press. The following criteria were used to screen participants in an initial interview: age 75 years and older, community-dwelling, had visited a primary care physician within the past 3 years, had no severe cognitive impairment (Rapid Dementia Screening Test [RDST] score of 4 or less),[15] can walk independently (or with a cane), willingness to participate in group exercise classes for at least 6 months, has access to transportation, has no significant hearing and vision impairments, and had no regular exercise in the past 12 months.

The interview was also used to exclude participants based on the following exclusion criteria: severe cardiac, pulmonary or musculoskeletal disorders; comorbidities associated with greater risk of falls, such as Parkinson disease and stroke; and use of psychotropic drugs. Written informed consent was obtained from each participant for the trial in accordance with the guidelines approved by the Kyoto University Graduate School of Medicine and the Declaration of Human Rights, Helsinki, 1975.

Study design and randomization

Participants were randomized into two groups. Opaque envelopes bearing group names were numbered and the 157 participants were then randomly assigned to either the CC ($n = 78$) or SC ($n = 79$) group.

Intervention

All participants received 45 min of group training sessions once a week for 24 weeks. Participants were randomly assigned to one of the two training groups: standardized training with CC and standardized training with SC.

The exercise class was individualized for each group and supervised by a physiotherapist. Each exercise class used a standardized format that included 10 min of moderate-intensity aerobic exercise, 15 min of progressive strength training, 10 min of flexibility and balance exercises, and 10 min of cool-down activities. The aerobic exercise consisted of movement of the legs, trunk and arms to involve all joints and major muscle groups in activities, such as dancing. Strength training consisted of progressive resistive exercises using an elastic band. A sequence of progressively more difficult exercises was also carried out to improve static and dynamic balance. Although exercises could be carried out in a sitting position, the importance of carrying the exercises out in a standing position to improve balance was stressed. Physiotherapists evaluated the participants twice during the study period to ensure adherence with exercise protocols during classes.

Complex course with obstacle negotiation exercise

In the CC training field, the flags and obstacles were positioned as shown in Figure 1.[10] Flags were randomly

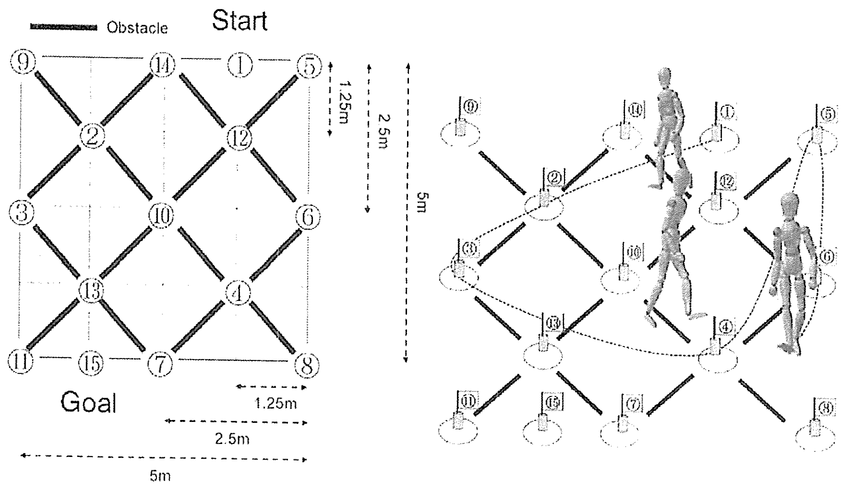

Figure 1 Schematic representation of the complex course obstacle negotiation exercise. Participants were asked to pass sequentially from numbers 1 to 15 as quickly and as correctly as possible during obstacle avoidance.

moved for each trial. Participants in the CC group were asked to sequentially pass from number 1 to 15 while avoiding the obstacles (Fig. 1). A 30-cm diameter circle was drawn on the ground around each flag, and the participants were required to step in the circle to pass the flag. The height of the flag was 30 cm. The tester gave the following instructions to participants, "Please move to flag number 15 as quickly and correctly as possible while avoiding obstacles". Throughout the weeks, the obstacles were made increasingly more difficult for participants to notice. The obstacles consisted of 16 wooden white (contrasting the floor colour) blocks (3, 100 and 1 cm in height, length and width, respectively) in weeks 1–6, wooden black blocks (2, 100 and 1 cm in height, width and depth, respectively) in weeks 7–12, wooden dark brown blocks (1, 100 and 1 cm in height, length and width, respectively) in weeks 13–18 and wooden brown (matching the floor colour) blocks (0.5, 100 and 1 cm in height, length and width, respectively) in weeks 19–24. Flag and obstacle positions were changed on each day of training. Participants carried out two sets of the CC program per training session.

Simple course with obstacle negotiation exercise

Participants were asked to walk along a walkway at a self-selected speed and to avoid contact with the obstacles. These sessions were designed as controls for the additional physical activity in the CC session. Participants walked along a level walkway, 15 m in length. The obstacles used in the simple course were as follows: six wooden white (contrasting the floor colour) blocks (3, 100 and 1 cm in height, length and width, respectively) in weeks 1–6, wooden black blocks (2, 100 and 1 cm in height, length and width, respectively) in weeks 7–12, wooden dark brown blocks (1, 100 and 1 cm in height, width and depth, respectively) in weeks 13–18, wooden brown (matching the floor colour) blocks (0.5, 100 and 1 cm in height, length and width, respectively) in weeks 19–24. These obstacles were placed across the walkway at intervals randomly ranging from 30 to 150 cm for each day of training. Each participant carried out six walking trials.

Falls and fall-related fractures

The primary outcome of this trial was the occurrence of falls and fall-related fractures during the follow-up period of 12 months after the intervention was completed. Falls were defined as all situations in which a participant suddenly and involuntarily came to rest on the ground or at a surface lower than their original station.[16] Falls resulting from extraordinary environmental factors (e.g. traffic accidents or falls while riding a bicycle) were excluded. The participants were asked to record any falls in fall diaries mailed every month by research assistants. If participants failed to send the fall diaries, research assistants collected data on falls over the telephone. All participants who had fallen were interviewed during these calls using a structured questionnaire about a fall event and its consequences. The diagnosis of fractures was based on radiological evidence of fracture.

Secondary outcome measures

For all participants, the following six measurements were obtained: 10-m walking time,[17] the timed up and go (TUG) test,[18] the functional reach (FR) test,[19] the one-leg stand (OLS) test,[20] the SC test, and the CC test. A physiotherapist blinded to group allocation administered these measures at baseline, on completion of the 24-week intervention. All baseline measures were completed before randomization. Before the study started, all staff members received training on correct protocols for administering all assessment measures included in the study from one of the authors (MY). If a walking aid was normally used at home, this aid was used during the TUG test, 10-m walking, SC test and CC test.

In the 10-m walking, participants walked 15 m at a speed at which they felt comfortable. A stopwatch was used to record the time required to reach the 10 m point that was marked in the middle of this walk. The time recorded in two trials was averaged as the walking score.

In the TUG test, participants were asked to stand up from a standard chair with a seat height of 40 cm, walk a distance of 3 m at a maximum pace, turn, walk back to the chair, and sit down. The time recorded from two trials was averaged to obtain the TUG score.

In the FR test, each participant was positioned next to a wall with one arm raised at 90° and fingers extended. A meter stick was mounted on the wall at shoulder height. The distance that a participant could reach while extending forward from an initial upright posture to the maximal anterior leaning posture without moving or lifting the feet was visually measured in centimetres according to the position of the tip of the third finger against the mounted meter stick. The distances measured in two trials were averaged to obtain the FR score.

In the OLS test, participants were instructed to start from a standing position with a comfortable base as support with eyes open and arms at their sides. They were then instructed to stand unassisted on either leg. OLS was measured in seconds from the time one foot was lifted from the floor to when it touched the ground or the standing leg.

In the SC test, participants were asked to walk along the walkway at a self-selected speed and to avoid contact with the obstacles. Participants walked along a level walkway, 10 m in length. The simple course consisted of six wooden white (contrasting the floor colour) blocks (3, 100 and 1 cm in height, length and width, respectively). These obstacles were placed across the walkway at intervals of 2 m. Time to complete each walking trial was recorded using a stopwatch. The number of obstacles contacted was recorded. The SC test was carried out only once for each participant at each time-point.

In the CC test, the field test was the same as that used for the CC exercise (Fig. 1). The complex course consisted of 16 wooden white (contrasting the floor colour) blocks (3, 100 and 1 cm in height, length and width, respectively). The test–retest reliability using the intraclass correlation coefficient was 0.935. The positions in which the flags and obstacles were placed are shown in Figure 1. The tester gave the following instruction to the participants: "Please move to number 15 as quickly and as correctly as possible while avoiding obstacles". Time to complete each walking trial was recorded using a stopwatch. The number of obstacles contacted was recorded. The CC test was carried out only once for each participant at each time-point.

Required sample size

A previous study showed that approximately 30% of the Japanese community-dwelling adults, 65 years of age or older, fall at least once a year. This result was consistent with a previous report.[2] We designed the current study to detect a 30% difference in fall rate between the groups (CC group = 10% and SC group = 30%), for which a sample size of 72 per group ($\alpha = 0.05$ and power = 80%) was necessary. With an estimated dropout rate of 5%, a final sample size of 76 per group was required.

Statistical analysis

Baseline characteristics of CC and SC groups were compared to examine the comparability of the two groups. Differences in the physical function variables between the two groups were analyzed using the Student's t-test or χ^2-test.

The number of falls and fall-related fractures was calculated from the beginning of the study to the participant's death, withdrawal from the trial or the end of the 12-month follow-up period. Confidence intervals (CI) for the falls and fall-related fracture rates were calculated assuming that the number of falls and fall-related fractures followed a negative binomial distribution. Incidences of falls and fall-related fractures with 95% CI were calculated for participants in the CC and SC groups, and compared using negative binomial regression analysis. Results were presented using incident rate ratios (IRR) with their 95% CI. The effect of exercise on outcome measurements was analyzed using a mixed 2 × 2 (group [CC and SC groups] × time [pre-training, post-training]) analysis of variance. Post-hoc Tukey tests were used to assess which group or time periods showed significant differences.

Data were entered and analyzed using the SPSS (Windows version 18.0, SPSS, Chicago, IL, USA). A P-value of <0.05 was considered statistically significant for all analyses.

Results

Overall, 207 people were screened, and 157 (75.8%) who met the inclusion criteria for the trial and agreed to participate were enrolled (Fig. 2). Of the individuals not meeting the inclusion criteria ($n = 50$), most were excluded because they had exercised regularly in the 6 months before screening. Seven people who were eligible for the study withdrew their participation after a

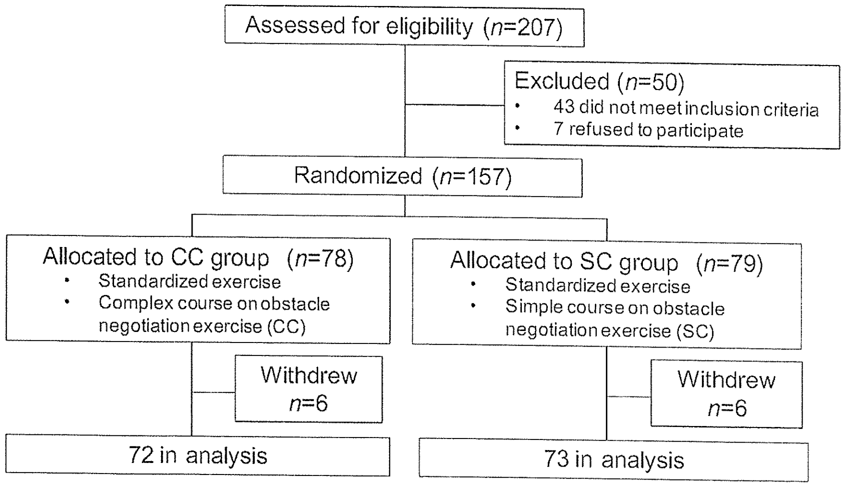

Figure 2 A flow chart showing the distribution of participants throughout the trial.

Table 1 Baseline characteristics of the study participants in complex course obstacle negotiation exercise and simple course obstacle negotiation exercise groups

Characteristic	CC group $n = 72$	SC group $n = 73$	P
Age (years)	85.8 ± 5.9	85.3 ± 5.7	0.71
Bodyweight, (kg)	44.9 ± 9.8	47.8 ± 9.4	0.36
Height (cm)	145.1 ± 9.0	147.8 ± 9.2	0.22
Female, n (%)	63 (88.7%)	64 (86.5%)	0.59
RDST (points)	7.5 ± 2.2	7.6 ± 2.5	0.80
Medication (n)	3.7 ± 2.9	3.8 ± 3.3	0.89
Walking aids, n (%)	34 (47.2%)	30 (41.1%)	0.28
Falls in the last year, n (%)	28 (38.9%)	29 (39.7%)	0.59

CC, complex course obstacle negotiation exercise; **RDST**, Rapid Dementia Screening Test; **SC**, simple course obstacle negotiation exercise.

telephone screening. Of the 157 individuals selected for the study, 145 (92.3%) completed the 12-month follow up: 72 in the CC group (92.3%) and 73 in the SC group (92.4%).

All 24 scheduled intervention sessions were completed. The median relative adherence was 96% (25th to 75th percentile, 88–100%) in the CC group and 96% (88–100%) in the SC group. No fall incidents occurred during training sessions or testing. No health problems, including cardiovascular or musculoskeletal complications, occurred during training sessions or testing. Minor problems observed in both groups were muscle ache after the first training sessions and fatigue. All problems were managed easily using adjustment of the intervention, and they improved during the intervention. Participants in the CC and SC groups were comparable and well matched with regard to their baseline characteristics (Table 1).

Two participants (2.8%) in the CC group and 19 (26.0%) in the SC group had experienced falls during the 12 months after the exercise program. During the 12-month follow-up period, the IRR of falls in the SC group against the CC group was 9.37 (95% CI 2.26–38.77). One participant (1.4%, distal radius $n = 1$) in the CC group and 8 (10.9%, distal radius $n = 2$; proximal humerus $n = 3$; hip $n = 3$) in the SC group experienced fall-related fractures during the 12-month follow-up period. The IRR of fall-related fractures in the SC group against the CC group was 7.89 (95% CI 1.01–61.49).

Participants in the CC group had significantly greater improvements in secondary outcome measures including the performance time and the number of obstacles contacted under the CC condition ($P < 0.05$) (Table 2). However, other secondary outcome measures were not significantly different between the two groups ($P > 0.05$).

Table 2 Functional fitness items in each group at pre- and postintervention

Item	Pre-intervention	Postintervention	Group × Time Interaction *F*-value	*P*-value
10-m walking time (s)				
CC group	16.2 ± 7.4	14.1 ± 4.4	0.01	0.91
SC group	18.6 ± 10.0	15.1 ± 6.2		
10-m walking step (*n*)				
CC group	27.5 ± 8.1	26.6 ± 7.2	1.08	0.30
SC group	31.6 ± 14.3	27.3 ± 9.9		
TUG (s)				
CC group	13.6 ± 5.2	13.7 ± 5.3	0.18	0.67
SC group	18.3 ± 9.4	14.8 ± 7.1		
Functional reach (cm)				
CC group	15.9 ± 9.3	16.1 ± 8.2	3.21	0.08
SC group	13.8 ± 7.5	14.0 ± 6.8		
One leg standing (s)				
CC group	6.0 ± 7.4	5.1 ± 5.7	2.56	0.12
SC group	3.2 ± 3.6	4.9 ± 6.1		
Performing time under simple course (s)				
CC group	15.9 ± 8.8	14.5 ± 4.0	0.28	0.60
SC group	17.2 ± 7.9	15.5 ± 5.9		
Performance time under complex course (s)				
CC group	132.6 ± 36.9	105.7 ± 18.7	5.63	0.02
SC group	152.0 ± 54.1	140.9 ± 53.8		
No. obstacles contacted under simple course (times)				
CC group	1.0 ± 1.1	0.3 ± 1.1†	0.60	0.44
SC group	1.2 ± 1.4	0.2 ± 0.6†		
No. obstacles contacted under complex course (times)				
CC group	1.9 ± 2.1	0.1 ± 0.4†	5.62	0.02
SC group	1.7 ± 2.0	1.8 ± 2.8†		

†As calculated by group comparison $P < 0.05$. Columns indicating pre- and postintervention values are expressed as mean (SD). **CC,** complex course obstacle negotiation exercise; **SC,** simple course obstacle negotiation exercise; TUG, timed up and go test.

Discussion

The SC exercise is an obstacle-avoidance program under simple task conditions. The CC exercise is an obstacle-avoidance program under complex task conditions, and is designed to address multiple domains, such as attention, short-term memory and balance, which when impaired have been shown to increase fall risk.[21] The present results show that the CC program can improve the performance time of the CC test. This result is consistent with our previous study.[10]

In the CC program, the obstacles were organized to gradually increase the level of difficulty. Therefore, it is possible that the CC program improves the participants' performance by decreasing the number of obstacles contacted under the CC conditions. This result suggested that the obstacle-avoidance program, which increases attention demands for obstacles during walking under complex task conditions, is useful for the improvement of obstacle-avoidance capability. Previous studies have shown that the obstacle-avoidance success rate was decreased by the presence of a secondary task.[22,23] Furthermore, elderly individuals with a high risk for falls chose an early transfer of gaze strategy when challenged with an obstacle under dual-task conditions.[13] The present study showed that our CC program could improve divided attention under complex task conditions.

The differences in fall and fall-related fracture rates between CC and SC groups were significant during the 12 months after the intervention. The improvement in the number of obstacles contacted and the performance time of the CC test became apparent in increased capacity in a real-life environment.

There were several limitations of the present study that warrant mention. First, the participants were probably more motivated and showed greater interest in health and fall risk than the general population of older adults. Second, the information about the medications for osteoporosis was not included in the analysis. It is possible that such medications have an effect on the fracture incidence.

The results of this RCT suggest that the CC program is more effective in improving the number of obstacles contacted and the performance time of the CC test than the SC program. In addition, participants who received individualized obstacle-avoidance training under complex tasks combined with a traditional intervention showed a lower incidence rate of falls and fall-related fractures during the 12-month follow-up period. These results implicated the importance of population-based prevention programs to reduce falls and fall-related fractures in older adults (75 years and older). This is the first study to show that the obstacle-avoidance program, focusing on attention demands of obstacles during walking under complex task conditions, is useful in preventing falls and fall-related fractures in older adults. A larger study is needed to confirm the present results and to evaluate the most effective exercises for the prevention of falls and fall-related fractures.

Acknowledgments

The authors acknowledge Ms Kazue Hatakeyama, Ms Ai Tanahashi, Ms Masako Tanaka, Ms Makiko Ashida, Mr Minoru Ikeda, Mr Yusuke Terasaki and Mr Toyoki Yasuda for their contributions to the data collection. None of the authors have conflict of interest or financial disclosures.

Disclosure statement

The authors declare no conflict of interest.

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Geriatrics Gerontology 1st Impact Factor in June 2010 Medline Indexed

Geriatr Gerontol Int 2011

ORIGINAL ARTICLE

Faster decline of physical performance in older adults with higher levels of baseline locomotive function

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Aim: The purpose of this longitudinal study was to determine whether the rate of decline in community-dwelling older adults varies according to baseline locomotive function levels.

Methods: This longitudinal study was conducted in community-dwelling older adults in Kyoto, Japan. In addition to information about falls, physical performance was assessed using a series of tests, including 10-m walking time, timed up and go (TUG) test, functional reach, one-leg stand test, and five chair stand test. The outcomes for each patient were measured once in 2009 and then followed up 1 year later. The change in physical performance was then determined. We divided the participants into tertiles (T1, T2, and T3) according to timed up and go test results, and the differences among the three groups were compared.

Results: Of the 252 individuals who were enrolled in the study, 231 (91.6%) completed the 12-month follow-up: 77 in the T1 group; 78 in the T2 group; and 76 in the T3 group. The T1 group showed a significantly larger decrease than the T2 and T3 groups in the 10-m walking time and TUG tests ($P < 0.05$). However, there were no significant differences in functional reach, one-leg standing test, or five chair stand test among the three groups. In the T1 group, the number of falls and elderly who had developed fear of falling increased during the study period.

Conclusions: This study demonstrated that elderly with the highest baseline performances were more likely to show a greater decline in locomotive performance than the other groups. Further study is required to elucidate the mechanism of faster physical functional decline in robust elderly. **Geriatr Gerontol Int 2011; ••: ••–••.**

Keywords: level of frailty, locomotive function, longitudinal study, robust elderly.

Introduction

Maintenance of physical performance in later life is an important component of healthy aging.[1] Walking speed has been identified as one of the most influential physical performances associated with deterioration in activity of daily living among older adults.[2] The timed up and go test (TUG) is a simple tool developed to screen basal mobility performance, which has been shown to be significantly associated with activity of daily living in frail older adults.[3] Thus, evaluating walking speed and TUG is important for predicting the risk of functional decline.

Several cross-sectional studies have shown that a gradual decline in physical performance is significantly

Accepted for publication 25 August 2011.

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doi: 10.1111/j.1447-0594.2011.00757.x

associated with age.[4,5] Several longitudinal studies have also found a time-dependent decline in the physical performance of community-dwelling older adults.[6,7] However, few studies have addressed the factors involved in longitudinal change in physical performance. Therefore, we conducted several studies to demonstrate that the differential factors are related to daily activities and depend on community-dwelling older adults' level of frailty.[8] Our data suggests that a resistance training program is effective for improving physical performance in frail elderly, but not in non-frail elderly,[9] indicating a difference in the effect of physical training on elderly persons with varying levels of physical fitness. Therefore, it is important to examine longitudinal changes in the physical performance of elderly persons with varying levels of physical fitness.

The purpose of this longitudinal study was to determine whether the rate of decline in older adults differs according to baseline locomotive function levels.

Methods

Participants

Study participants were recruited through ads in the local press requesting healthy community-dwelling volunteers. A total of 252 Japanese participants, 65 years and older living in Kyoto city, were included in the baseline survey in October 2009. One year later in October 2010, the second survey was conducted. We screened 332 people, and 252 who agreed to participate were enrolled. Of the 252 individuals, 231 (91.7%) completed the 12-month follow-up (Fig. 1).

The screening process was used to exclude participants based on the following criteria: severe cardiac, pulmonary, or musculoskeletal disorders; comorbidities associated with an increased risk of falling such as

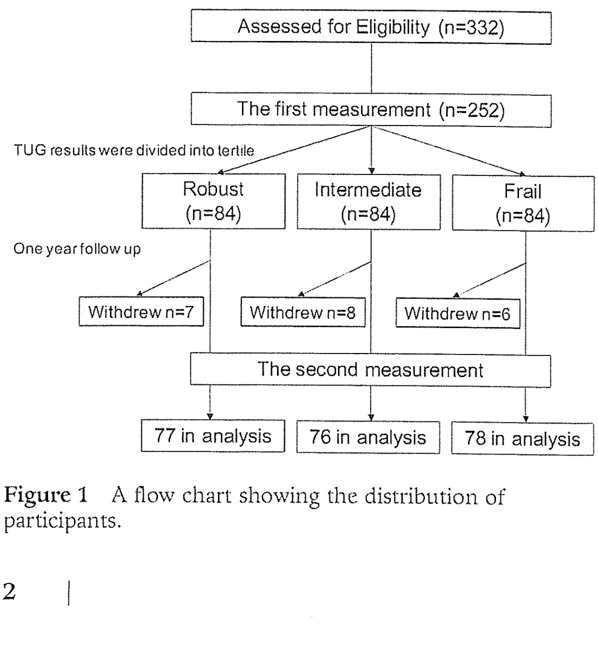

Figure 1 A flow chart showing the distribution of participants.

Parkinson's disease and stroke; and use of psychotropic drugs. Written informed consent was obtained from each participant for the trial in accordance with the guidelines approved by the Kyoto University Graduate School of Medicine and the Declaration of Helsinki, 1996.

Outcome measures

All participants underwent five tests for measurements: 10-m walking time,[10] TUG test,[3] functional reach (FR),[11] one-leg standing (OLS) test,[12] and five chair stand (5CS) test.[13] Outcome measures were conducted in October 2009 and October 2010. No exercise program was prescribed to participants during the interim period. Before the study started, all researchers were trained by one of the authors (MY) on correct protocols for administering the assessment measures. If a participant normally used a walking aid, this aid was used during the 10-m walking time and TUG tests.

In the 10-m walking time test, participants walked 15 m at a comfortable pace, as determined by the individual. A stopwatch was used to record the time required to reach the 10-m point that was marked in the middle of the path. The test-retest reliability using the intertrial correlation coefficient (ICC; 1.1) was 0.943. The better performance of the two trials was used as the walking time score in the analysis. In the TUG test, participants were asked to stand up from a standard chair with a seat height of 40 cm, walk a distance of 3 m at a maximum pace, turn, walk back to the chair, and sit down. The test-retest reliability using the ICC (1.1) was 0.929. The TUG score was defined as the better performance of the two trials. In the FR test, each participant was positioned next to a wall with one arm raised at 90° and fingers extended. A meterstick was mounted on the wall at shoulder height. The distance that a participant could reach while extending forward from an initial upright posture to the maximal anterior leaning posture, without moving or lifting the feet, was measured in centimeters according to the position of the tip of the third finger against the mounted meterstick. The distances measured in the two trials were averaged to obtain the FR score. The test-retest reliability using the ICC (1.1) was 0.915. In the OLS test, participants were instructed to start from a standing position with a comfortable base as support with their eyes open and arms at their sides. They were then instructed to stand unassisted on either leg. OLS was measured in seconds from the time one foot was lifted from the floor to when it touched the ground or the standing leg. The test-retest reliability using the ICC (1.1) was 0.905. The participants stopped the OLS if the time exceeded 60 s. In 5CS, participants were asked to stand up and sit down five times as quickly as possible. They were timed from the initial sitting position to the final standing position at the end of the fifth stand. The test-retest reliability using the ICC (1.1) was 0.954. The 5CS score was defined as the better performance of the two trials. The percent change for physical performance was calculated as follows:

Percent change (%) = 100 × (2010 measurement − 2009 measurement)/2009 measurement

Falls and the fear of falling

Participants were interviewed about falling during the past year and their fear of falling in 2009 and 2010. Falls were defined as all situations in which a participant suddenly and involuntarily came to rest upon the ground or a surface lower than their original station.[14] Falls resulting from extraordinary environmental factors (e.g. traffic accidents or falls while riding a bicycle) were excluded.

We assessed participants' fear of falling by asking a single yes-or-no question with a high test-retest reliability, "Are you afraid of falling?"[15] This question was asked during the interviews in 2009 and 2010. The test-retest reliability using the kappa coefficient was 0.960.

Statistical analysis

We divided the participants into tertiles (T1, T2, and T3) according to TUG test results. TUG was chosen for several reasons. First, it is a simple measure of physical function that involves lower extremity strength, dynamic balance, gait, and agility. Second, TUG has been shown to identify physical function limitations in geriatric patients in a clinical setting.[16,17]

We analyzed the outcome measurements using a two-way ANOVA. Tukey tests were used for post-hoc analysis. Differences in the physical variables between elderly who had or had not fallen and between those with or without a fear of falling were analyzed by two-way ANOVA. Data were analyzed using SPSS v. 18.0 for Windows (Chicago, IL, USA). A P-value of <0.05 was considered statistically significant for all analyses.

Results

Of the 252 individuals, 231 (91.7%) completed the 12-month follow-up: 77 in T1 group (91.7%), 78 in T2 group (92.9%) and 76 in T3 group (90.5%) (Fig. 1). There were no significant differences in all performance measurements and age between men and women.

Baseline characteristics

There were significant differences in age (T1, 73.9 ± 6.6; T2, 79.1 ± 7.0; T3, 82.0 ± 6.9; $F = 25.2$, $P < 0.001$), walking time (T1, 7.4 ± 1.4 sec; T2, 9.7 ± 2.8 sec; T3, 12.7 ± 2.6 sec; $P < 0.05$), TUG (T1, 6.9 ± 0.9 sec; T2, 9.2 ± 0.9 sec; T3, 12.7 ± 1.3 sec; $P < 0.05$), FR (T1, 29.0 ± 7.0 cm; T2, 26.5 ± 6.7 cm; T3 21.3 ± 7.1 cm; $P < 0.05$), OLS (T1, 19.5 ± 13.6 sec; T2, 10.0 ± 10.7 sec; T3, 5.4 ± 5.5 sec; $P < 0.05$), and 5CS (T1, 8.5 ± 2.4 sec; T2, 10.4 ± 2.1 sec; T3, 13.5 ± 3.8 sec; $F = 28.0$, $P <$ 0.001). There were no significant differences in height or weight (Table 1).

Follow-up measures

There were significant differences in walking time (T1, 8.0 ± 1.9 sec; T2, 9.3 ± 2.0 sec; T3, 12.3 ± 2.7 sec; $P < 0.001$), TUG (T1, 7.5 ± 1.5 sec; T2, 9.3 ± 1.8 sec; T3, 13.0 ± 3.2 sec; $P < 0.001$), FR (T1, 30.2 ± 8.8 cm; T2, 27.6 ± 8.4 cm; T3, 21.0 ± 6.5 cm; $P < 0.001$), OLS (T1, 19.0 ± 12.8 sec; T2, 8.7 ± 9.4 sec; T3, 4.3 ± 3.8 sec; $P < 0.001$), and 5CS (T1, 7.4 ± 2.0 sec; T2, 9.5 ± 3.2 sec; T3, 13.6 ± 5.5 sec; $P < 0.001$) (Table 1, Fig. 2).

Group-time interactions are summarized in Table 1. A statistically significant group-time interaction was observed for walking time and TUG ($P < 0.05$).

Falls and fear of falling

In the T1 group, the number of falls and elderly who had developed a fear of falling increased between baseline and follow-up (falls, 19.5% to 27.2%; fear of falling, 13.0% to 26.0%). There were no significant differences in FR, OLS, or 5CS. In T2 and T3 groups, the number of falls and elderly who had developed fear of falling did not change between baseline and follow-up (Table 1).

Characteristics of elderly with or without falls

Group-time interactions are summarized in Tables 2, 3, and 4. In T1 group, a statistically significant group-time interaction was observed for TUG and 5CS ($P < 0.05$). However, we did not find any significant differences in T2 and T3 groups (Tables 2, 3 and 4).

Characteristics of elderly with or without fear of falling

Group-time interactions are summarized in Tables 2, 3, and 4. In T1 group, a statistically significant group-time interaction was observed for TUG ($P < 0.05$) (Table 2). In T2 group, a statistically significant group- time interaction was observed for TUG and 5CS ($P < 0.05$) (Table 3). In T3 group, there were no significant differences (Table 4).

Discussion

In the current study, we have shown that elderly with the highest baseline performances are more likely to show a decline in locomotive performance than the

Table 1 Comparison of outcome measurements among the three groups

	T1 (≤8.2) (n = 77)	T2 (8.3–10.9) (n = 76)	T3 (≥11.0) (n = 78)	F-value	P-value	*Post-hoc*
Age	73.9 ± 6.6	79.1 ± 7.0	82.0 ± 6.9	25.2	<0.001	†‡§
Height (cm)	157.1 ± 9.0	155.0 ± 8.1	155.8 ± 10.9	0.5	0.620	–
Weight (kg)	57.7 ± 9.8	56.5 ± 8.3	54.5 ± 10.1	0.7	0.492	–
Gender, female	57 (74.0)	60 (78.9)	60 (76.9)			–
Falls, n (%)						
2009	15 (19.5)	20 (26.3)	26 (33.3)			
2010	21 (27.2)	22 (28.9)	28 (35.9)			
Fear of falling, n (%)						
2009	10 (13.0)	29 (38.2)	36 (46.2)			
2010	20 (26.0)	30 (39.5)	37 (47.4)			
Walking time (sec)						
2009	7.4 ± 1.4	9.7 ± 2.8	12.7 ± 2.6	9.227	<0.001	†‡§
2010	8.0 ± 1.9	9.3 ± 2.0	12.3 ± 2.7			†‡§
Change (%)	5.3 ± 17.6	–5.1 ± 25.2	–3.4 ± 20.1			†‡
Timed up and go (sec)						
2009	6.9 ± 0.9	9.2 ± 0.9	12.7 ± 1.3	3.361	0.037	†‡§
2010	7.5 ± 1.5	9.3 ± 1.8	13.0 ± 3.2			†‡§
Change (%)	5.8 ± 14.1	2.4 ± 16.2	2.6 ± 22.6			†‡
Functional reach (cm)						
2009	29.0 ± 7.0	26.5 ± 6.7	21.3 ± 7.1	1.254	0.291	
2010	30.2 ± 8.8	27.6 ± 8.4	21.0 ± 6.5			
Change (%)	5.5 ± 28.0	5.8 ± 28.1	–3.3 ± 37.9			
One-leg standing (sec)						
2009	19.5 ± 13.6	10.0 ± 10.7	5.4 ± 5.5	0.906	0.439	
2010	19.0 ± 12.8	8.7 ± 9.4	4.3 ± 3.8			
Change (%)	–5.3 ± 41.4	–2.9 ± 31.2	–6.7 ± 32.8			
Five chair stand (sec)						
2009	8.5 ± 2.4	10.4 ± 2.1	13.5 ± 3.8	0.217	0.885	
2010	7.4 ± 2.0	9.5 ± 3.2	13.6 ± 5.5			
Change (%)	–10.0 ± 24.5	–6.4 ± 33.3	1.0 ± 31.7			

†T1 *versus* T2. ‡T1 *versus* T3. §T2 *versus* T3.

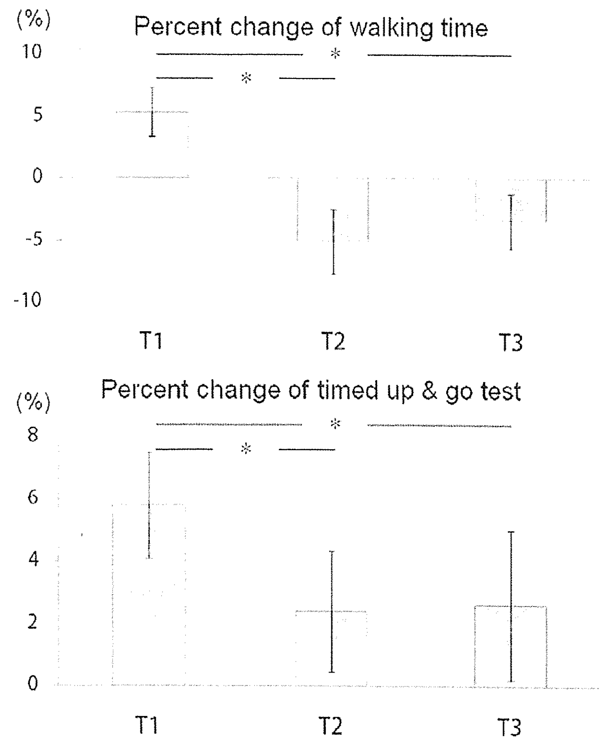

Figure 2 Percent change in the walking time and timed up and go tests among the three groups. The means ± SEM in T1, T2, and T3 groups are shown. $*P < 0.05$.

others. These results are quite unexpected. However, Koster *et al.* compared the leg strength of octogenarians and septuagenarians, and found more rapid decline in leg strength in septuagenarians.[18] Moreover, it has been reported that active community-dwelling elderly men and women respectively lose 0.8% and 0.7% of lean leg mass per year on average.[18] These characteristics of the aging process might account for why the T1 group showed a greater decrease in locomotive functions. Yet, it is possible that a floor effect may account for this longitudinal maintenance of physical performance in the T2 and T3 groups. Previous cross-sectional studies have shown an age-dependent gradual decline in locomotive function,[4,5] while longitudinal studies have shown a time-dependent decline in locomotive function in community-dwelling older adults.[6,7] The subjects of these studies were community-dwelling older adults with a relatively high level of performance, presumably equivalent to our study's T1 or T2 groups. However, participants in our study had a wider range of physical performance levels. For example, the reference values for TUG were 8.1 s for persons aged 60 to 69 years old, 9.2 s for persons aged70 to 79 years, and 11.3 s for persons aged 80 to 99 years.[19] The reference values for the T1 group was 6.9 s, 9.2 s for the T2 group, and 12.7 s for the T3 group. Thus, the level of physical performance may have affected our results.

The T1 group showed a significantly larger decrease in 10-m walking time and TUG than the other groups. An earlier longitudinal study indicated that the age-related decline was accelerated in lower extremity performance.[7] Walking speed, in particular, is a good predictor for the onset of functional dependence in a Japanese community population.[2] In the same manner, TUG has been shown to be significantly associated with activities of daily living function in frail older adults.[3] Thus, physical training, such as resistance training, maintains level of activity of daily living in healthy elderly is very important.

The T1 group showed an increase in falls (19.5% to 27.2%) and fear of falling (13.0% to 26.0%) in 2010. In general, at least one-third of people aged 65 and older fall at least once annually.[20,21] In addition, the major risk factor for fear of falling is shown to be history of at least one fall.[22] In the T1 group, elderly with a fear of falling were more likely to show a decline in locomotive performance than elderly without a fear of falling. Several studies have indicated that people who are afraid of falling appear to enter a debilitating spiral of loss of confidence, restricted physical activities, physical frailty, lack of social participation, falls, and loss of independence.[23–28] Therefore, it is possible that the increased fear of falling is associated with decreased locomotive function in T1 group.

There were several limitations of this study that warrant mention. First, although we used TUG to define frailty, TUG may not be sufficient to define frailty. The Edmonton Frail Scale adopts eight other domains such as cognition, general health status, functional independence, social support, medication use, nutrition, mood, and continence other than TUG.[29] Further study is required to test the levels of these domains in this cohort. Second, the standard deviations for the percent change values are quite large, which shows major individual differences. These factors may have affected the current results. Third, the results of men and women were combined in this research because of the relatively small sample size. A larger sample size is required to analyze in each gender. Finally, participants were probably more motivated and showed greater interest in health than the general population of older adults.

This was a longitudinal study to demonstrate that the participants with the highest baseline levels of performance were more likely to show a greater decline in locomotive performance than the other groups. Further study is needed to explore the mechanism of a faster decline in physical performance in the robust elderly. Future work should also be done to determine whether the effects of a training program on physical performance differ according to the level of physical well-being.

Table 2 Characteristics of elderly who have or have not fallen and with or without a fear of falling in T1 group

	Falls (2010)				Fear of falling (2010)			
	Falls (2010) (n = 21)	No falls (n = 56)	F-value	P-value	Fear (n = 20)	No fear (n = 57)	F-value	P-value
Age	76.0 ± 6.6	73.1 ± 6.5		0.08†	74.1 ± 7.5	73.9 ± 6.3		0.90†
Height (cm)	155.5 ± 9.7	157.6 ± 8.8		0.49†	158.7 ± 9.7	156.1 ± 8.5		0.34†
Weight (kg)	61.0 ± 14.1	56.2 ± 7.2		0.26†	62.0 ± 10.5	55.0 ± 8.6		0.08†
Gender, female	15 (71.4%)	42 (75.0%)		0.48‡	13 (65.0%)	44 (77.2%)		0.22‡
Walking time (sec)								
2009	7.3 ± 1.5	7.4 ± 7.5	0.03	0.88	7.6 ± 1.6	7.4 ± 1.6	0.11	0.74
2010	8.4 ± 2.5	7.8 ± 1.2			8.9 ± 1.9	7.6 ± 1.8		
Change (%)	8.9 ± 18.6	3.8 ± 15.9			12.3 ± 17.5	2.4 ± 15.4		
Timed up and go (sec)								
2009	7.0 ± 0.9	6.8 ± 0.7	4.34	0.04	7.0 ± 1.1	6.9 ± 0.8	23.22	0.00
2010	7.9 ± 1.6	7.3 ± 1.2§			8.2 ± 1.1	7.1 ± 0.9§		
Change (%)	8.8 ± 15.1	4.6 ± 13.2			12.4 ± 16.9	3.5 ± 11.8		
Functional reach (cm)								
2009	27.7 ± 6.9	29.5 ± 7.0	0.80	0.37	27.9 ± 6.1	29.4 ± 7.3	0.65	0.42
2010	26.7 ± 7.6	30.5 ± 8.9			28.0 ± 7.4	31.0 ± 9.2		
Change (%)	−1.2 ± 24.5	8.2 ± 29.1			4.7 ± 32.8	5.8 ± 26.2		
One-leg standing (sec)								
2009	23.6 ± 32.4	20.5 ± 14.0	0.21	0.65	23.8 ± 14.1	20.7 ± 24.4	0.35	0.56
2010	15.0 ± 11.7	21.0 ± 12.9			22.7 ± 14.9	17.8 ± 11.7		
Change (%)	−11.2 ± −47.2	2.8 ± 39.3			−14.3 ± 27.9	−1.4 ± 46.1		
Five chair stand (sec)								
2009	8.2 ± 2.5	8.6 ± 2.3	6.33	0.02	8.6 ± 2.2	8.5 ± 2.5	0.44	0.51
2010	8.0 ± 2.4	7.1 ± 1.8§			7.5 ± 2.2	7.3 ± 1.9		
Change (%)	−6.1 ± −25.4	14.1 ± 16.4			−10.6 ± 22.1	−13.1 ± 17.2		

†Student's t-test. ‡χ^2 test. §As calculated by group comparison.

Table 3 Characteristics of elderly who have or have not fallen and with or without fear of falling in T2 group

	Falls (2010)				Fear of falling (2010)			
	Falls (2010) (n = 22)	No falls (n = 54)	F-value	P-value	Fear (n = 30)	No fear (n = 46)	F-value	P-value
Age	79.9 ± 6.6	78.8 ± 7.2		0.57†	79.5 ± 7.9	78.9 ± 6.5		0.72†
Height (cm)	155.0 ± 8.9	155.0 ± 8.0		0.99†	154.6 ± 7.1	155.2 ± 8.9		0.83†
Weight (kg)	58.0 ± 8.5	56.0 ± 8.4		0.62†	57.9 ± 6.8	55.7 ± 9.2		0.54†
Gender, female	17 (77.3%)	43 (79.6%)		0.52‡	22 (73.3%)	38 (82.6%)		0.25‡
Walking time (sec)								
2009	10.3 ± 1.8	9.5 ± 3.0	0.09	0.76	10.1 ± 2.0	9.6 ± 3.1	0.10	0.75
2010	9.8 ± 1.7	9.2 ± 1.9			10.0 ± 2.0	9.0 ± 1.6		
Change (%)	−6.4 ± 0.1	−4.5 ± 0.3			−1.8 ± 15.0	−7.2 ± 30.0		
Timed up and go (sec)								
2009	9.4 ± 0.7	9.3 ± 0.7	2.70	0.11	9.5 ± 0.7	9.3 ± 0.7	4.31	0.05
2010	9.9 ± 1.5	9.2 ± 1.9			10.1 ± 1.9	8.9 ± 1.6§		
Change (%)	3.1 ± 0.1	−4.8 ± 0.2			4.3 ± 14.2	−7.3 ± 16.7		
Functional reach (cm)								
2009	25.4 ± 6.4	26.9 ± 6.8	0.43	0.52	24.2 ± 5.7	28.0 ± 6.9	0.36	0.56
2010	24.2 ± 6.2	27.9 ± 8.9			24.7 ± 6.9	29.4 ± 8.9		
Change (%)	−4.9 ± 0.3	6.3 ± 0.3			6.3 ± 29.9	5.5 ± 27.1		
One-leg standing (sec)								
2009	7.7 ± 9.1	11.1 ± 14.4	0.00	0.99	11.1 ± 17.4	9.5 ± 9.7	0.01	0.93
2010	6.3 ± 4.9	10.1 ± 11.1			5.8 ± 5.3	11.0 ± 11.4		
Change (%)	−1.4 ± 0.4	−0.1 ± 0.3			−13.8 ± 30.8	7.7 ± 35.1		
Five chair stand (sec)								
2009	10.6 ± 3.1	10.3 ± 1.5	0.01	0.93	10.7 ± 1.5	10.2 ± 2.4	5.84	0.02
2010	10.4 ± 4.2	9.2 ± 2.8			11.3 ± 3.0	8.2 ± 2.7§		
Change (%)	−8.9 ± 0.1	−12.4 ± 0.2			2.6 ± 17.7	−22.0 ± 16.8		

†Student's t-test. $^{\ddagger}\chi^2$ test. §As calculated by group comparison.

Table 4 Characteristics of elderly who have or have not fallen and with or without fear of falling in T3 group

	Falls (2010)				Fear of falling (2010)			
	Falls (2010) (n = 28)	No falls (n = 50)	F-value	P-value	Fear (n = 37)	No fear (n = 41)	F-value	P-value
Age	82.0 ± 6.4	82.0 ± 7.3		0.99†	83.9 ± 7.6	80.1 ± 6.8		0.02†
Height (cm)	155.6 ± 9.8	155.9 ± 11.5		0.94†	153.2 ± 10.8	161.5 ± 8.0		0.07†
Weight (kg)	49.2 ± 5.4	56.3 ± 10.8		0.14†	52.0 ± 11.6	59.5 ± 8.4		0.09†
Gender, female	20 (71.4%)	40 (80.0%)		0.17‡	28 (75.7%)	32 (78.0%)		0.35‡
Walking time (sec)								
2009	11.87 ± 2.01	12.99 ± 2.94	3.53	0.07	12.6 ± 2.7	12.6 ± 2.7	0.14	0.71
2010	12.47 ± 2.89	12.27 ± 2.54			12.3 ± 2.2	12.4 ± 3.1		
Change (%)	2.91 ± 14.69	−7.09 ± 21.47			−3.6 ± 22.4	−3.4 ± 17.2		
Timed up and go (sec)								
2009	12.92 ± 1.08	12.73 ± 1.21	0.52	0.47	12.9 ± 1.2	12.7 ± 1.1	0.36	0.55
2010	12.91 ± 2.58	13.28 ± 4.03			13.3 ± 3.5	13.0 ± 3.7		
Change (%)	−3.17 ± 17.78	2.40 ± 26.53			2.0 ± 23.7	3.4 ± 23.8		
Functional reach (cm)								
2009	22.42 ± 7.11	20.69 ± 7.06	0.37	0.55	22.4 ± 7.5	20.3 ± 6.6	0.01	0.92
2010	22.92 ± 5.56	20.11 ± 6.72			21.6 ± 5.9	20.3 ± 7.0		
Change (%)	5.68 ± 25.46	−2.01 ± 43.44			−5.1 ± 37.1	1.4 ± 39.3		
One-leg standing, sec								
2009	4.47 ± 3.28	5.29 ± 5.80	0.16	0.69	4.7 ± 4.0	5.3 ± 6.0	0.49	0.49
2010	3.67 ± 2.92	4.29 ± 4.08			3.6 ± 3.2	4.6 ± 4.2		
Change (%)	−8.63 ± 38.58	−0.62 ± 45.06			−2.7 ± 41.0	−1.4 ± 45.9		
Five chair stand (sec)								
2009	14.89 ± 3.39	12.90 ± 3.94	0.41	0.53	13.1 ± 3.4	14.3 ± 4.6	1.79	0.19
2010	15.72 ± 6.70	12.57 ± 4.67			14.1 ± 6.3	12.7 ± 3.8		
Change (%)	3.44 ± 24.64	−4.73 ± 30.54			1.6 ± 30.8	−8.0 ± 24.5		

†Student's t-test. ‡χ^2 test.

Acknowledgements

We would like to thank the Geriatrics Institute (Kyoto, Japan) for its contribution to data collection and Mr Yasukuki Kohma for his helpful advice. None of the authors has a conflict of interest or financial disclosure.

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Title:

Development of a new fall risk assessment index for older adults

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Keywords: index, fall risk, older adults, risk assessment