

Fall Risk Characteristics of the Elderly in an Exercise Class

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Abstract The purpose of this study was to clarify the fall risk characteristics of the elderly participating in an exercise class.

The subjects were comprised of 206 elderly Japanese aged 60 or older (37 males, 169 females) who participated in an exercise class, approved by the local government, once a week for 6 months. Physical fitness and ADL capability were evaluated by the physical fitness test of the Ministry of Education, Culture, Sports, Science and Technology. Fall risk was evaluated using the Fall Assessment Chart. Subjects were divided into two groups, high fall risk (total fall risk score ≥ 5) and low fall risk (total fall risk score < 5), and the percentage of subjects in the high risk group was calculated.

The percentage of subjects with a high fall risk was 15.8%, lower than the documented rate of the community-dwelling elderly in a previous study. Significant differences between fall risk groups were found in balance and ADL capabilities of walking, holding and changing posture and muscular strength. These functions also were significantly related to fall risk elements such as fall anxiety and slipping or stumbling at home in the partial correlation analyses.

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Introduction

In Japan, where the mean age of society is rapidly increasing (Ministry of Health and Welfare, 1989, 1997), falls in the elderly have become an important social problem because of resulting bone fractures, post fall syndromes, and decreased quality of life (Grisso et al., 1991). In previous studies of falls in the elderly (Yasumura et al., 1991, 1994; Shibata, 1997; Niino et al., 2000, 2003; Suzuki, 2003), internal and external

fall risk factors, such as physical function characteristics, lifestyle and physical environment, were typically examined. These previous studies suggested that the incidence of falls in the elderly is closely related to a decline in muscular strength, balance, cardiovascular function, and ADL capabilities, i.e. walking, and holding and changing posture (Shibata, 1997; Suzuki, 2003; Suzuki et al., 1999; Myers et al., 1996; Sorock and Labiner, 1992; Nevitt et al., 1991). In addition, internal factors (i.e. visual disorders or medication usage) and external factors (i.e. living environment, type of footwear, height of stair steps, and floor level), which are closely related to falls in the elderly have been clarified (Suzuki, 2003). Although a fall risk assessment chart for the elderly has been developed based on findings of these previous studies (Suzuki, 2001), there are only a few reports examining the fall risk characteristics of the elderly.

Yokoya et al. (2007) examined fall risk characteristics in the community-dwelling elderly. They found that one in four elderly persons had a high fall risk and that the fall risk decreased among the elderly who commonly take outside trips or exercise. These findings indicate that regular physical activity is important for the prevention of falls in the elderly.

Recently, in Japanese society, local governments have implemented a range of measures to promote the health and well-being of the elderly. However, the effect of these health measures on the reduction of fall risk in the elderly is not sufficiently known. It is expected that the elderly who participate in these health promotion activities (exercise classes) have superior physical function and their fall risk should be lower than that of the community-dwelling elderly population. To clarify the effect of health promotion on the prevention of falls in the elderly, their physical and fall risk characteristics, and the relationship between fall risk and physical function should be examined. These findings can prove useful for health promotion.

This study targeted the elderly participating in an exercise class approved by the local government, and aimed to clarify their fall risk and physical function characteristics.

Methods

1. Subjects

Subjects in this study included 206 elderly (37 males, height: 161 ± 6.7 cm, weight: 59.4 ± 6.5 kg, BMI: 22.9 ± 1.6 kg/m² and mean age: 71.2 ± 6.9 years, and 169 females, height: 150.3 ± 5.2 cm, weight: 51.8 ± 7.3 kg, BMI: 22.8 ± 3.0 kg/m² and mean age: 70.3 ± 5.5 years) aged 60 and over, living in Kaga City, Ishikawa Prefecture. Survey and measurements in this study were conducted 6 months after the start of the exercise class. We explained the aim and design of the study to each subject before obtaining their written informed consent. This study was approved by the Human Subject Ethical Committee of Kanazawa University.

2. Exercise class

The exercise class in this study was carried out as part of a health promotion service sponsored by the local government in Kaga City, and the main purpose of this class was to provide opportunities for regular exercise and interaction among the elderly. The exercise class was held once a week at a community hall or a public citizen's hall in Kaga City. The exercise class consisted of a 90-minute program (a. walking on tatami mats (10 minutes), b. stretching (10 minutes), c. strength training (sit-up, push-up with bent-knees and squats; 5 repetitions of each exercise for two sets) (10 minutes), and d. recreational sports ("Petanque", "Curolling", "Shuffleboard", rhythm exercise, etc.) (60 minutes)).

3. Physical functional assessment

This study evaluated physical characteristics (height, weight, body mass index, percent body fat), physical fitness and ADL capability. Physical fitness and ADL capability were evaluated by the physical fitness test for the elderly approved by the Ministry of Education, Culture, Sports, Science and Technology of Japan. This physical fitness test consists of 6 items: grip strength, sit up, sit and reach, one leg balance with eyes open, 10 m obstacle walk and 6 minute walk. The ADL test consisted of 12 items representing ADL capability domains of walking ability, changing and holding posture, balance, muscular strength and dexterity (manual activity).

4. Fall risk assessment

We used the Fall Assessment Chart of Suzuki et al. (2001), which is comprised of 15 items relating to internal and external factors (Appendix). Each item was assessed on a dichotomous scale. The fall risk is considered to be high if a total score of 5 or higher is obtained. This chart has been used in previous studies as an indicator of fall risk in the elderly (Suzuki, 2003; Suzuki, 2001; Yokoya et al., 2007).

5. Statistical analyses

1) Physical functional characteristics

Mean values of each physical fitness test were compared with national standard values approved by the Ministry of

Education, Culture, Sports, Science and Technology, in Japan. Furthermore, in order to investigate the physical function characteristics of the elderly participating in an exercise class, gender and age differences in physical fitness and ADL capability were examined by a two-way (gender x age) analysis of variance (ANOVA). When a main effect was significant, we conducted a multiple comparison analysis, according to Tukey's HSD test.

2) Fall risk characteristics

The frequency distribution of the total fall score was calculated. According to a previous study, we defined a score of 5 or over as an indicator of a high risk of falling, and calculated the percentage of subjects with a high risk.

In the fall risk assessment chart used in this study, the following three items were seen as important indicators for screening fall risk: "In the past year, have you slipped or stumbled and then fallen down?" "At a pedestrian crossing, can you cross the road while the light is green?" and "Can you walk continuously for about 1 km?" We compared the fall risk characteristics in these three items between high and low fall risk groups.

3) Relationship between physical functional and fall risk characteristics

a. Difference in physical function between high and low fall risk groups

In order to clarify the physical fitness elements closely associated with fall risk, the differences in physical fitness and ADL tests scores were examined between high and low fall risk groups by an analysis of covariance (ANCOVA) with a covariate of age.

b. Relationships between fall risk factors and physical function

The fall risk assessment chart used in this study consisted of several factors. To determine the fall risk factor closely associated with physical function, we calculated the partial correlation coefficient between each fall risk item and each physical fitness or ADL item with the covariate of age.

The significance level in this study was set at $p < 0.05$.

Results

1. Characteristics of physical function

Table 1 and Table 2 show descriptive statistics and gender and age-related the differences in physical fitness and ADL capability, respectively. Compared with assessment criteria of the physical fitness test approved by the Ministry of Education, Culture, Sports, Science and Technology, physical fitness scores for each gender and age group were ranked "C" or "D". This suggests that the physical functional level of the elderly in this study is average.

As in the results of a two-way ANOVA, there was no significant interaction in any of the physical fitness and the

Table 1 Gender and age differences in physical fitness test

		60 s	65 s	70 s	75 s	80 s	Two-way ANOVA	
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Source	Multiple comparisons
Grip strength	Male	39.1±4.5	33.6±5.0	35.0±6.7	30.8±1.4	29.5±5.5	Gender *	60 s, 65 s, 70 s, 75 s, 80 s: M>F Age * M: 60 s>75 s,80 s; F: 60 s, 65 s>80 s
	Female	25.2±4.4	23.9±4.3	22.3±3.3	21.8±3.7	17.5±5.3	Interaction	
Sit-up	Male	16.6±6.8	13.0±3.7	10.5±7.4	8.0±6.4	2.2±3.5	Gender * 60 s, 65 s: M>F	Age * M: 60, 65 s>80 s Interaction*
	Female	7.8±6.9	6.2±4.9	5.0±4.7	5.2±5.1	2.4±3.6	Gender	
Sit and reach	Male	43.7±7.8	29.0±9.2	36.2±7.1	26.3±4.7	32.4±9.8	Age * F: 60 s>70 s	Interaction
	Female	42.3±9.9	39.4±7.3	34.2±14.3	35.5±7.9	34.7±10.1	Gender *	
One leg balance with eyes open	Male	115.3±12.5	76.6±49.0	80.1±42.2	36.2±37.1	18.8±25.2	Age * M: 60 s>75 s,80 s	Interaction F: 60 s>70 s,75 s, 80 s; 65 s>70 s,75 s
	Female	87.5±37.6	69.6±42.1	45.9±40.9	32.9±30.9	11.9±14.3	Gender *	
10m obstacle walk	Male	6.3±1.0	7.0±2.8	7.3±1.5	7.7±1.1	8.8±1.3	Age * F: 60 s,65 s>70 s, 75 s	Interaction
	Female	7.2±1.3	7.4±1.1	8.6±1.1	8.3±1.4	9.9±2.9	Gender *	
6 minutes walk	Male	682.9±46.4	582.5±95.0	575.2±64.5	523.7±59.6	475.0±87.3	Age * M: 60 s>75 s,80 s	Interaction F: 60 s>70 s,75 s,80 s; 65 s>70 s,75 s
	Female	594.6±59.9	564.9±51.6	511.8±110.7	517.9±66.5	453.6±105.9	Gender *	
General score	Male	45.7±6.6	35.5±9.9	36.2±8.2	26.8±5.6	21.2±7.8	M: 60s>75s,80s; 65s,70s>80s	Age * F: 60 s,65 s>70 s,75 s,80 s Interaction
	Female	40.8±7.9	37.2±6.0	31.5±6.8	31.0±7.3	23.1±9.4	Gender *	

Note: 60 s: 60 to 64 years, 65 s: 65 to 69 years, 70 s: 70 to 74 years, 75: 75 to 79 years, 80 s: 80 years or over.

Sample size of each gender and age group was as follows; male: 60 s=7, 65 s=8, 70 s=11, 75 s=6, 80 s=5;

females: 60 s=29, 65 s=53, 70 s=49, 75 s=31, 80 s=7). *: $p<0.05$, ns: not significance

ADL items. There were significant age-related differences in all physical fitness items and in the general scores. As with the results of multiple comparisons, test scores tended to decrease with age, and remarkable decreases were found in the groups 75 years and older. Significant gender differences were only found in grip strength and sit-ups for multiple comparisons.

As shown in Table 2, a significant interaction was found only in item no. 8 (putting on pants or a skirt while standing), significant age differences were found in the male group and a remarkable decrease was found in the 80-years-and-over group. A significant gender difference was found only in item no. 11 (carrying). There were significant age differences in all ADL items, except for items no. 9 (buttoning or unbuttoning shirts) and 11, and ADL scores tended to decrease with age.

As there were no remarkable gender differences in physical fitness and ADL capability levels, later analyses were conducted by combining gender groups, because the sample size of the elderly male was small.

2. Fall risk characteristics in the elderly participating in exercise class

The proportion of elderly with a high fall risk score (total fall score ≥ 5) was 15.8%.

In the fall risk assessment chart used in this study, three items, “In the past year, have you slipped or stumbled and then

fallen down?”, “At a pedestrian crossing, can you cross the road while the light is green?”, and “Can you walk continuously for about 1 km?” were important items for screening fall risk. In the high fall risk group (34 subjects), 12 subjects (35.3%) experienced falls in the past year. Nine subjects could not walk continuously 1 km, and two (5.9%) could not also cross a pedestrian crossing while the light was green and one had fallen in the past year. On the other hand, in the low fall risk group (181 subjects), 19 subjects (10.5%) had experienced a fall in the past year. Six subjects (3.3%) could also not cross a pedestrian crossing while the light was green, 4 subjects (2.2%) could not walk continuously 1 km, and only one subject could not achieve either of these things. The high fall risk group tended to have inferior walking ability to the low fall risk group.

3. Relationship between fall risk and physical function characteristics in the elderly participating in an exercise class

1) Differences in physical function between the high and low fall risk groups

Table 3 and Table 4 show the results comparing physical fitness and ADL tests scores between high and low fall risk groups with covariance of age, respectively. Significant differences were found in balance ability (one leg balance with

Table 2 Gender and age differences in ADL test

ADL items		60 s	65 s	70 s	75 s	80 s	Two-way ANOVA	
		Mean±SD	Mean±SD	Mean±SD	Mean±SD	Mean±SD	Source	Multiple comparisons
1. Walking	Male	2.9±0.4	2.5±0.5	2.6±0.5	2.2±0.4	2.0±1.0	Gender Age Interaction	*
	Female	2.6±0.5	2.4±0.5	2.3±0.6	2.2±0.5	2.3±0.5		
2. Running	Male	2.0±0.6	2.4±0.5	2.3±0.5	2.0±0.0	1.4±0.5	Gender Age Interaction	* F: 65 s>70 s
	Female	2.1±0.4	2.2±0.6	1.8±0.6	1.9±0.6	1.7±0.5		
3. Jumping a ditch	Male	2.6±0.5	2.9±0.4	2.8±0.4	2.7±0.5	2.0±0.7	Gender Age Interaction	*
	Female	2.7±0.5	2.6±0.5	2.4±0.6	2.3±0.5	2.1±0.4		
4. Climbing up stairs	Male	3.0±0.0	2.8±0.5	2.5±0.7	2.3±0.5	2.0±0.7	Gender Age Interaction	*
	Female	2.4±0.6	2.5±0.5	2.2±0.6	2.2±0.7	2.1±0.4		
5. Standing from sitting posture (Seiza)	Male	3.0±0.0	2.8±0.5	2.8±0.4	2.3±0.5	2.2±0.4	Gender Age Interaction	*
	Female	2.6±0.5	2.6±0.5	2.3±0.7	2.5±0.5	2.3±0.5		
6. One foot balance with open eyes	Male	2.7±0.5	2.5±0.8	2.7±0.5	2.0±0.9	2.0±0.7	Gender Age Interaction	* F: 60 s, 65 s>70 s, 75 s, 80 s
	Female	2.7±0.5	2.6±0.5	2.2±0.6	2.2±0.5	1.9±0.7		
7. Standing on the bus or train	Male	3.0±0.0	2.9±0.4	2.6±0.7	2.3±0.5	2.0±0.7	Gender Age Interaction	* M: 60 s>80 s
	Female	2.4±0.5	2.3±0.5	2.2±0.6	2.1±0.4	2.3±0.5		
8. Putting on pants or skirt while standing	Male	3.0±0.0	2.9±0.4	3.0±0.0	2.3±0.8	1.8±0.8	Gender Age Interaction*	* M: 60 s, 65 s, 70 s>80 s
	Female	2.8±0.4	2.8±0.5	2.7±0.6	2.7±0.6	2.6±0.5		
9. Buttoning or unbuttoning shirts	Male	2.4±0.8	2.3±0.7	2.4±0.7	2.0±0.9	1.8±0.8	Gender Age Interaction	*
	Female	2.3±0.5	2.3±0.5	2.2±0.5	2.1±0.7	1.9±0.7		
10. Folding up and down a futons	Male	3.0±0.0	2.8±0.5	2.9±0.3	2.3±0.5	2.2±0.4	Gender Age Interaction	*
	Female	2.8±0.4	2.6±0.5	2.6±0.5	2.6±0.5	2.6±0.5		
11. Carrying	Male	3.0±0.0	2.8±0.5	2.8±0.4	2.7±0.5	2.4±0.5	Gender Age Interaction	* 70 s: M>F
	Female	2.5±0.5	2.5±0.5	2.3±0.6	2.3±0.5	2.1±0.4		
12. Sit-up	Male	2.4±0.8	2.3±0.7	2.0±0.8	2.0±0.9	1.6±0.5	Gender Age Interaction	*
	Female	2.0±0.7	1.8±0.8	1.6±0.6	1.5±0.6	1.6±0.8		
Total score	Male	33.0±2.8	31.5±4.2	31.5±2.7	27.2±4.8	23.4±6.2	Gender Age Interaction	* 70 s: M>F * M: 60 s, 65 s, 70 s>80 s F: 60 s, 65 s>70 s, 75 s
	Female	30.0±3.5	29.3±3.6	26.7±4.3	26.5±3.6	25.4±3.4		

Note: 60 s: 60 to 64 years, 65 s: 65 to 69 years, 70 s: 70 to 74 years, 75: 75 to 79 years, 80 s: 80 years or over.

Sample size of each gender and age group was as follows; male: 60 s=7, 65 s=8, 70 s=11, 75 s=6, 80 s=5; females: 60 s=29, 65 s=53, 70 s=49, 75 s=31, 80 s=7).

*: $p<0.05$, ns: not significance

eyes open), and the score was higher in the low fall risk group than in the high fall risk group.

As shown in Table 4, significant differences were found in the items concerning walking ability (no. 2: running and 4: climbing up stairs), holding and changing posture (no. 5: standing from sitting posture), balancing ability (no. 6: one foot balance with open eyes, 7: standing on the bus or train, 8: putting on pants or a skirt while standing), and muscular strength (no. 11: carrying). These scores were higher in the

low-risk group than in the high-risk group.

2) Relationship between fall risk and physical function characteristics

In order to clarify the difference in the relationship between fall risk and physical function characteristics according to fall risk factor, we calculated partial correlation coefficients between each fall risk item and physical fitness or ADL tests scores by controlling the effect of age (Table 5 and Table 6).

Factors concerning balance ability had a significant correlation with all physical fitness and ADL test items, except for grip strength. Fall risk factors concerning walking ability were significantly correlated with 6 minutes of walking and many ADL items (no. 1: walking, 2: running, 3: jumping a ditch, 4: climbing stairs, 5: standing from sitting posture, 7: standing on the bus or train, and 8: putting on pants or a skirt while standing). Hospitalization in the preceding year was significantly correlated with the ADL capabilities of walking, carrying, holding and changing posture (no. 3: jumping, 4: climbing stairs, 5: standing from sitting posture and 11: carrying). “Slipping or stumbling at home” was significantly correlated with many ADL items (item no. 2: running, 4: climbing stairs, 5: standing from sitting posture, 7: standing on the bus or train, 8: putting on pants or a skirt, 10: folding up

and down a futon and 11: carrying), although there was no significant relationship with physical fitness tests. “Anxiety about falling” was significantly correlated with grip strength and sit-ups and with many ADL capabilities such as walking, balancing, muscular strength, and carrying (no. 1: walking, 2: running, 4: climbing stairs, 7: standing on the bus or train, 10: folding up and down a futon and 11: carrying).

Discussion

Maintenance and improvement of physical function is very important for fall prevention in the elderly. Local governments throughout the country have conducted various health promotions for physical and mental health. However, there has been no study of the effect of participation in these health promotions on fall prevention or risk.

Yokoya et al. (2007) indicated that regular activities outside of the home are closely related to fall risk in the community dwelling elderly. Participation in an exercise class is expected to have positive effects on physical function and health status as the class guarantees opportunities for regular exercise and interaction with others.

In this study of the elderly participating in an exercise class for 6 months, 15.8% had a high fall risk. This rate was lower than that of the community dwelling elderly (Yokoya et al., 2007). The physical fitness level of the elderly in this study was almost average, compared with the national standard value of the physical fitness test. These results indicate that regular activities such as going out or light exercise may be useful for the prevention of falls among the elderly, even if there is no remarkable effect on physical fitness level.

Therefore, we examined the fall risk and physical function characteristics of the elderly participating in an exercise class.

Table 3 Comparison of physical fitness between high- and low-fall risk groups

Variables	High-fall risk group	Low-fall risk group	ANCOVA F-values
	Mean±SD	Mean±SD	
Grip strength	22.9±5.1	25.4±6.4	
Sit-up	5.0±5.2	7.0±6.1	
Sit and reach	35.0±9.7	37.2±10.7	
One leg balance with eyes open	34.2±32.4	63.6±44.7	*
10 m obstacle walk	8.6±1.3	7.8±1.6	
6 minutes walk	504.9±89.2	555.0±86.3	
General score	30.1±8.5	35.2±8.5	
Age	73.1±5.2	69.8±5.7	*

Note: High-fall risk group composed of the subjects with a total score of 5 or higher. ANCOVA was conducted with covariate of age. *: $p < 0.05$

Table 4 Comparison of ADL capability between high- and low-fall risk groups

ADL dominans	ADL items	High-fall risk group	Low-fall risk group	ANCOVA F-values
		Mean±SD	Mean±SD	
Walking ability	1 Walking	2.1±0.6	2.4±0.5	
	2 Running	1.6±0.6	2.1±0.5	*
	4 Climbing up stairs	2.1±0.6	2.4±0.6	*
Changing and holding posture	5 Standing from sitting posture (Seiza)	2.1±0.6	2.6±0.5	*
	6 One foot balance with open eyes	2.0±0.6	2.5±0.6	*
Balance	7 Standing on the bus or train	2.0±0.5	2.4±0.5	*
	8 Putting on pants or skirt while standing	2.4±0.7	2.8±0.5	*
Mascular strength	3 Jumping a ditch	2.3±0.6	2.6±0.2	
	10 Folding up and down a futons	2.5±0.5	2.7±0.5	
	11 Carrying	2.2±0.6	2.5±0.5	*
	12 Sit-up	1.5±0.6	1.8±0.7	
dexterity	9 Buttoning or unbuttoning a shirts	2.1±0.7	2.2±0.6	
	Total score	25.0±4.6	28.9±3.9	*

Note: ANCOVA was conducted with covariate of age. *: $p < 0.05$

Table 5 Partial correlations between fall risk and physical fitness items with covariate of age

Fall risk items	Physical fitness test items							General score
	Grip strength	Sit-up	Sit and reach	One leg balance with eyes open	10 m obstacle walk	6 minutes walk		
1 Fall in the preceding year	0.01	0.04	0.10	0.02	-0.10	0.13	0.11	
2 Pedestrian crossing	-0.08	0.03	0.05	0.01	-0.02	0.05	0.06	
3 Walking 1km	0.01	0.04	-0.03	0.00	0.09	-0.30*	-0.03	
4 Standing on one foot to put on a sock	-0.09	-0.17*	-0.28*	-0.22*	0.34*	-0.15*	-0.33*	
5 Wringing out a wet towel	-0.17*	-0.14*	-0.07	0.06	0.04	-0.04	-0.10	
6 Hospitalization in the preceding year	-0.04	-0.05	0.01	-0.10	0.05	0.06	-0.02	
7 Feel dizzy on standing up	-0.17*	-0.08	0.03	0.00	0.02	-0.03	-0.03	
8 Stroke	0.10	0.11	-0.05	-0.02	-0.02	-0.01	-0.03	
9 Diabetes	-0.05	-0.05	0.02	-0.08	-0.01	-0.02	-0.07	
10 Medication	0.02	0.07	-0.04	-0.02	-0.03	-0.06	0.04	
11 Sandals or Slippers	-0.07	-0.06	0.02	-0.05	-0.02	-0.01	0.00	
12 Seeing	-0.15*	-0.07	0.13	-0.06	0.09	-0.07	-0.05	
13 Hearing	-0.03	0.05	-0.02	0.00	-0.03	-0.04	0.00	
14 Slip at home	-0.11	-0.13	-0.05	-0.01	0.12	-0.09	-0.12	
15 Anxiety about falling	-0.22*	-0.16*	0.12	-0.01	0.04	-0.06	0.01	

Note: *: $p < 0.05$

Table 6 Partial correlations between fall risk and ADL items with covariate of age

Fall risk items	ADL test items														
	1. Walking	2. Running	3. Jumping a ditch	4. Climbing up stairs	5. Standing from sitting posture	6. One foot balance with open eyes	7. Standing on the bus or train	8. Putting on pants or skirt while standing	9. Buttoning or unbuttoning a shirts	10. Folding up and down a futons	11. Carrying	12. Sit-up	Total Score		
1 Fall in the preceding year	0.04	-0.10	0.07	-0.01	-0.15*	0.01	0.00	-0.02	0.06	0.01	0.03	-0.01	-0.01		
2 Pedestrian crossing	0.01	0.00	0.00	-0.04	-0.05	-0.05	-0.07	-0.13*	-0.03	-0.05	0.03	-0.06	-0.06		
3 Walking 1km	-0.22*	-0.18*	-0.14*	-0.27*	-0.19*	-0.13	-0.16*	-0.17*	-0.04	-0.07	-0.12	-0.25*	-0.25*		
4 Standing on one foot to put on a sock	-0.18*	-0.27*	-0.35*	-0.28*	-0.40*	-0.22*	-0.33*	-0.42*	-0.29*	-0.33*	-0.25*	-0.50*	-0.50*		
5 Wringing out a wet towel	-0.11	-0.10	-0.04	-0.02	-0.10	-0.11	-0.01	0.00	-0.06	-0.01	-0.03	-0.14*	-0.08		
6 Hospitalization in the preceding year	-0.08	-0.09	-0.17*	-0.17*	-0.15*	-0.10	-0.06	-0.08	-0.01	-0.09	-0.22*	0.01	-0.16*		
7 Feel dizzy on standing up	-0.09	-0.09	-0.10	-0.05	-0.09	-0.07	-0.19*	-0.08	-0.05	-0.09	-0.11	-0.17*	-0.17*		
8 Stroke	-0.01	-0.05	0.08	-0.07	0.01	0.05	0.06	-0.05	-0.04	0.04	0.02	0.06	0.01		
9 Diabetes	0.01	-0.12	0.04	-0.03	-0.11	-0.04	0.00	-0.03	0.14*	0.01	0.03	-0.04	-0.02		
10 Medication	-0.08	-0.08	0.02	0.03	-0.03	-0.08	-0.02	-0.01	0.10	0.00	-0.07	-0.05	-0.04		
11 Sandals or Slippers	0.08	0.16*	0.20*	0.07	0.00	8.00	0.03	0.16*	0.31*	0.06	0.01	-0.02	0.16*		
12 Seeing	-0.10	0.00	-0.03	0.01	-0.11	-0.10	-0.05	-0.07	-0.08	0.02	-0.05	0.02	-0.08		
13 Hearing	0.03	-0.06	-0.01	0.04	-0.08	-0.08	-0.11	-0.03	-0.12	0.05	0.08	0.13	-0.02		
14 Slip at home	-0.13	-0.15*	-0.10	-0.15*	-0.20*	-0.11	-0.19*	-0.20*	-0.06	-0.15*	-0.18*	-0.08	-0.24*		
15 Anxiety about falling	-0.18*	-0.25*	-0.10	-0.21*	-0.12	0.02	-0.16*	0.03	-0.12	-0.26*	-0.14*	-0.06	-0.21*		

Note: *: $p < 0.05$

High fall risk subjects experienced more falls in the previous year and had lower walking ability. Compared with physical function characteristics, the high fall risk group tended to have inferior physical function to the low fall risk group, and this trend was especially noticeable in the ability to maintain balance, walk, and hold and change posture. Therefore, the functional level of these physical functions is closely related to fall risk.

Furthermore, we examined which fall risk factors could be reduced with an improvement of physical function throughout an exercise class. A fall risk assessment chart used in this study was comprised of several internal and external factors, such as physical function, fall experience, anxiety about falling, and absence or existence of disease (Suzuki, 2001, 2003). We examined the relationship between each fall risk factor and physical functions.

As shown in the results, the fall risk items concerning balance ability were significantly correlated with almost all physical fitness and ADL test items. Factors regarding “anxiety about falling” and “slipping or stumbling at home” were significantly correlated with physical functions of muscular strength, walking, holding and changing posture, and carrying. Furthermore, significant relationships were found between “hospitalization in the preceding year” and ADL capabilities regarding mobility. Factors concerning disease (diabetes, stroke, medication, dizziness) did not show significant relationships with almost all physical fitness and ADL items, and there were individual differences in the relationships between fall risk and these diseases. For the elderly, improvement and maintenance of physical function also has a positive effect on risk factors such as “fall anxiety” or “slip or stumble at home”, and it is important to ensure opportunities for regular light exercise and activities outside the home.

Furthermore, the results obtained in this study may provide useful knowledge for exercise programs focusing on the prevention of falls in the elderly. An exercise program should focus on balance ability, muscular strength, walking and changing and holding posture, as improvement of these physical functions is thought to reduce fall risk.

However, the application of this study is limited because of the small male elderly sample and cross-sectional data. To further examine the gender differences of fall risk characteristics, a larger male elderly sample is required. Furthermore, longitudinal examination may be required to clarify whether participation in an exercise class or the above-mentioned exercise program reduces fall risk among the elderly.

In summary, participation in an exercise class decreased the proportion of the elderly with a high fall risk score, although their physical fitness level remained average. Balance ability, muscular strength and ADL capability (walking and changing and holding posture) differed between high and low fall risk groups. Improvements in these functions may provide a positive effect on suppressing fall risk, including fall anxiety and slipping or stumbling at home.

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Appendix

Fall Assessment Chart

- | | |
|--|---------------|
| 1. In the past year, have you slipped or stumbled and then fallen down? | 1. Yes; 0. No |
| 2. At a pedestrian crossing, can you cross the road while the light is green? | 0. Yes; 1. No |
| 3. Can you walk continuously for about 1 km? | 0. Yes; 1. No |
| 4. Can you stand on one foot and put a sock on the other foot? | 0. Yes; 1. No |
| 5. Are you strong enough to wring out a wet towel or cloth effectively? | 0. Yes; 1. No |
| 6. Have you been hospitalized in the past year? | 1. Yes; 0. No |
| 7. Do you ever feel dizzy on standing up? | 1. Yes; 0. No |
| 8. Have you ever had a stroke? | 1. Yes; 0. No |
| 9. Have you ever been diagnosed as having diabetes? | 1. Yes; 0. No |
| 10. Are you taking any sleeping drugs, blood pressure medications or tranquilizers? | 1. Yes; 0. No |
| 11. Do you wear sandals or slippers a lot every day? | 1. Yes; 0. No |
| 12. Can you see well (newspaper, people's faces, etc.)? | 0. Yes; 1. No |
| 13. Can you hear well (people talking, etc.)? | 0. Yes; 1. No |
| 14. Do you often slip or stumble when at home? | 1. Yes; 0. No |
| 15. Do you generally worry a lot about falling or do you refrain from going out because you are afraid of falling? | 1. Yes; 0. No |

Note: The scores in the above fifteen questions were totaled and subjects with scores of 5 or higher scores were evaluated as having a high risk of falling. This chart was translated from Japanese into English by the authors and corrected by native English speakers.