Three-year Follow-up of the Fall Risk and Physical Function Characteristics of the Elderly Participating in a Community Exercise Class

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Abstract Objectives: This study targeted the elderly participating in community exercise classes implemented by the local government, and followed their fall risk and physical function characteristics for three years. This study aimed to compare these changes between low and high fall risk individuals.

Methods: The participants consisted of 34 male and 163 female Japanese elderly people aged 60 years or over who participated in a community exercise class once a week for three years. Physical fitness and activities of daily living (ADL) capability were evaluated by the physical fitness test of the Ministry of Education, Culture, Sports, Science and Technology in Japan. The fall risk was evaluated using a Fall Assessment Chart (Suzuki, 2000), and if the total score was ≥5, the subject was assessed as a high fall risk. Significant changes in the fall risk characteristics were examined by McNemar's test. Significant changes in physical function characteristics (Physical fitness and ADL tests) were examined by two-way (fall risk group and pre-post) ANOVA.

Results: The fall risk and number of falling incidents decreased only for the high risk group. In addition to the observed decrease in risk and incidents, it was found that the elderly who exercised were able to maintain their physical function (ADL capability level) with regard to muscular strength, walking, and maintaining and changing posture over the course of the three-year study.

Conclusions: Effectiveness of the exercise class implemented by the local government for fall prevention was found for the high fall risk elderly. These findings indicate the possibility that health promotion activities based on exercise classes may be a prevention strategy for falls within the community-dwelling elderly by incorporating more diverse activities adapted to an individual's functional level. *J Physiol Anthropol 28(2): 55–62, 2009* http://www.jstage.jst.go.jp/browse/jpa2
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Introduction

An accidental fall can put the elderly at risk of injury and loss of independence. Previous studies have suggested that exercise effectively moderates fall risk in the elderly (Barnett et al., 2003; Buchner et al., 1997; Campbell et al., 1997, 1999; Faber et al., 2006; Inokuchi et al., 2007; Lord et al., 1995; Robertson et al., 2001; Wong et al., 2001). In many of these interventional studies, supervised exercise programs to prevent falls of the elderly were implemented by a trained specialist. Many successful interventions targeted deconditioned or aged individuals (Buchner et al., 1997; Campbell et al., 1997, 1999; Tinetti et al., 1994) rather than individuals drawn from the general community (Buchner et al., 1997; Campbell et al., 1997, 1999; Tinetti et al., 1994). Thus, the appropriate intervention to prevent falls in the general population remains unknown (Carter et al., 2001). In Japan, many local governments implement various community exercise classes to promote the health status or quality of life (QOL) of the community-dwelling elderly. There are also various voluntary group activities run by the community-dwelling elderly. Although these activities are not necessarily supervised exercise programs aimed at fall prevention, these activities provide an opportunity for regular physical activity, going out, communicating with others, and maintaining overall health status and quality of life (QOL). There have been few reports determining the effectiveness of these health promotion activities on the fall risk of the general community-dwelling elderly, which is meaningful information for the local government and public health.

Yokoya et al. (2007, 2008) examined the fall risk of the community-dwelling elderly and reported that the habits of going out or exercise positively affect fall risk. However, the subsequent change characteristics of fall risk and its relationship with the physical function of the elderly who

continuously implement these habits has not been examined.

This study targeted the elderly participating in community exercise classes implemented by the local government. We assessed their fall risk and physical function and characterized them as low or high fall risk individuals. Then, we followed their fall risk and physical function characteristics for three years. This study aimed to compare the change in fall risk and physical function between low and high fall risk groups.

Methods

Participants

The healthy participants included people aged 60 and over, living in Kaga City, Ishikawa Prefecture. Measurements and surveys were conducted at the first and third year of participation. In the first year, 206 elderly (37 males and 169 females) participated in this study. Three years later, 197 out of 206 elderly completed the data survey. This study analyzed these 197 participants (34 males, mean height: 161.2 ± 6.7 cm, mean weight: 59.2 ± 6.5 kg, and mean age: 71.8 ± 6.8 years, and 163 females, mean height: 150.1 ± 5.3 cm, mean weight: 51.8 ± 7.4 kg, and mean age: 70.2 ± 5.6 years). Their mean ADL test scores (36-point scale) at onset were 29.6 ± 4.0 in males and 28.1 ± 4.0 in females, and they were independently living at home. At the onset of the study, we obtained written informed consent for their participation in the study. This study was approved by the Human Subject Ethical Committee of Kanazawa University.

Exercise class

The exercise class in this study was carried out as part of a health promotion service sponsored by the local government of Kaga City. The main purpose of this class was to provide opportunities for regular exercise and social interaction among the elderly for maintenance of health status and QOL. This exercise program is not necessarily designed to prevent falls in 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 was offered over a period of three years, and the participation rate for the three years was 74.1% (males: 74.3% and females: 73.9%).

The exercise class consisted of a 90-minute program (a. walking on tatami mats (10 minutes), b. stretching (10 minutes), c. strength training (sit-ups, push-ups with bent-knees, and squats: 5 repetitions of each exercise for two sets) (10 minutes), and d. recreational sports, such as "Petanque," "Curolling," "Shuffleboard," and rhythm exercise (60 minutes).

Fall risk and physical function assessments

"Fall risk" and physical function were assessed at baseline and after three years. We used the Fall Assessment Chart of Suzuki (2000, 2003), which is comprised of 15 items relating to internal and external factors (Appendix). Each item was assessed by the participants themselves on a dichotomous scale. If a total score of 5 or higher is obtained, the subject is assessed as "high risk" for a fall. This chart has been used in previous studies as an indicator of the risk of falling among the elderly (Suzuki, 2000, 2003; Yokoya et al., 2007, 2008). In this study, the risk level was assessed by the total score of this chart, and the risk characteristics were assessed by each item score.

This study evaluated the physical function (physical fitness and activities of daily living (ADL) capability) with a physical fitness test for the elderly, approved by the Ministry of Education, Culture, Sports, Science and Technology in Japan (2000). Physical fitness was evaluated by a battery of 6 tests: grip strength, sit up, sit and reach, one leg balance with eyes open, 10 m obstacle walk and a 6-minute walk. The ADL capability was evaluated by a questionnaire consisting of 12 items representing the ADL capability domains of walking ability, changing and maintaining posture, balance, muscular strength and dexterity (manual activity), with each item being evaluated by the participants themselves.

Statistical analyses

1. Change characteristics in fall risk

Changes in the proportions of high and low risk participants were evaluated by McNemar's test. Furthermore, significant changes in the response to each fall risk item were tested by a similar procedure.

2. Change characteristics in physical functions

Changes in physical fitness and ADL capability were examined by two-way repeated measure ANOVA (fall risk group and pre-post).

Table 1 Change characteristics in fall risk

		The third year			Chi square value
		High fall risk	Low fall risk	Total	
The first year	High fall risk	21	8	29	
	Low fall risk	9	159	168	0.1 ns
	Total	30	167	197	

Fall risk was assessed by total score of the fall assessment chart of Suzuki et al. (2001). If a total score of 5 or higher is obtained, the subject is assesed as a high fall risk. Changes in the proportions of high and low fall risk subjects were evaluated by McNemar's test. ns: not significant.

Table 2   Change characteristics of each fall risk item

Fall risk items			Low fall risk group				High fall risk group			
			The third year				The third year			
			Yes	No	Total	Chi-square value	Yes	No	Total	Chi-square value
1. Experience of falling in the preceding year	The first year	Yes	7	12	19		Yes 6	5	11	
		No	10	139	149	0.2	No 0	18	18	5.0*
		Total	17	151	168		Total 6	23	29	
2. Pedestrian crossing	The first year	Yes	159	4	163		Yes 27	0	27	
		No	4	1	5	0.0	No 0	2	2	0.0
		Total	163	5	168		Total 27	2	29	
3. Walking 1 km	The first year	Yes	158	8	166		Yes 20	1	21	
		No	0	2	2	8.0*	No 1	7	8	0.0
		Total	158	10	168		Total 21	8	29	
4. Standing on one foot to put on a sock	The first year	Yes	111	13	124		Yes 8	5	13	
		No	7	37	44	1.8	No 2	14	16	1.3
		Total	118	50	168		Total 10	19	29	
5. Wringing out a wet towel	The first year	Yes	160	3	163		Yes 26	0	26	
		No	3	2	5	0.0	No 0	3	3	0.0
		Total	163	5	168		Total 26	3	29	
6. Hospitalization in the preceeding year	The first year	Yes	4	3	7		Yes 6	1	7	
		No	2	159	161	0.2	No 0	22	22	1.0
		Total	6	162	168		Total 6	23	29	
7. Feel dizzy on standing up	The first year	Yes	10	1	11		Yes 14	1	15	
		No	5	152	157	2.7	No 0	14	14	1.0
		Total	15	153	168		Total 14	15	29	
8. Stroke	The first year	Yes	1	1	2		Yes 2	0	2	
		No	1	165	166	0.0	No 0	27	27	0.0
		Total	2	166	168		Total 2	27	29	
9. Deabetes	The first year	Yes	5	1	6		Yes 5	0	5	
		No	4	158	162	1.8	No 0	24	24	0.0
		Total	9	159	168		Total 5	24	29	
10. Medication	The first year	Yes	30	3	33		Yes 20	0	20	
		No	12	123	135	5.4*	No 0	9	9	0.0
		Total	42	126	168		Total 20	9	29	
11. Sandals or Slippers	The first year	Yes	111	19	130		Yes 17	5	22	
		No	7	31	38	5.5*	No 0	7	7	5.0*
		Total	118	50	168		Total 17	12	29	
12. Seeing	The first year	Yes	123	9	132		Yes 7	1	8	
		No	8	28	36	0.1	No 3	18	21	1.0
		Total	131	37	168		Total 10	19	29	
13. Hearing	The first year	Yes	145	9	154		Yes 15	0	15	
		No	4	10	14	1.9	No 1	13	14	1.0
		Total	149	19	168		Total 16	13	29	
14. Slip at home	The first year	Yes	4	5	9		Yes 11	3	14	
		No	7	152	159	0.3	No 0	15	15	3.0
		Total	11	157	168		Total 11	18	29	
15. Anxiety about falling	The first year	Yes	31	11	42		Yes 12	3	15	
		No	27	99	126	6.7*	No 3	11	14	0.0
		Total	58	110	168		Total 15	14	29	

This table shows the results of changes of each fall risk item for each fall risk group. The changes in the proportions of responses of each fall risk item were evaluated by McNemar's test. *: $p < 0.05$.

Table 3 Change charateritics in physical fitness

		N	The first year Mean	The first year SD	The first year Mean	The first year SD	2-way-ANOVA F-value	2-way-ANOVA p	Multiple comparisons
Grip strength	Low fall risk group	166	25.2	6.3	25.0	6.4	F1 10.6	0.001*	Low: 1st year>3rd year
	High fall risk group	29	23.3	5.0	23.0	5.1	F2 2.6	0.111	
							F3 0.4	0.503	
Sit-up	Low fall risk group	166	6.7	5.9	6.6	6.0	F1 2.7	0.103	
	High fall risk group	29	4.8	4.8	3.6	3.9	F2 5.2	0.024*	
							F3 2.4	0.124	
Sit and reach	Low fall risk group	166	37.0	10.8	38.5	8.4	F1 2.1	0.154	
	High fall risk group	29	35.2	9.6	34.4	7.1	F2 2.9	0.092	
							F3 2.1	0.154	
One leg balance with eyes open	Low fall risk group	166	62.2	44.3	58.1	42.2	F1 3.6	0.059	
	High fall risk group	29	35.6	33.0	30.2	32.3	F2 11.5	0.001*	
							F3 0.1	0.797	
10 m obstacle walk	Low fall risk group	166	7.8	1.6	7.7	1.6	F1 0.0	0.873	
	High fall risk group	29	8.6	1.3	8.7	1.4	F2 9.4	0.002*	
							F3 1.5	0.223	
6 minutes walk	Low fall risk group	166	556.4	76.1	535.1	96.2	F1 21.4	0.000*	Low, High: 1st year>3rd year
	High fall risk group	29	499.9	89.9	460.7	102.2	F2 15.7	0.000*	3rd year: low>high
							F3 1.9	0.174	
General score	Low fall risk group	166	35.0	8.5	34.6	8.9	F1 13.3	0.000*	High: 1st year>3rd year
	High fall risk group	29	30.1	8.5	27.3	8.0	F2 13.2	0.000*	3rd year: low>high
							F3 7.6	0.006*	

Changes of each physical fitness test item were evaluated by two-way repeated meaure ANOVA (fall risk group and pre-post change), F1: pre-post change, F2: fall risk group, F3: interaction, *: $p < 0.05$.

Results

Change characteristics in fall risk

The percentage of high risk participants was 14.7% (29 participants) in the first year and 15.2% (30 participants) in the third year, which was not a significant statistical difference (Table 1). Eight participants (27.6%) in the high risk group became low risk three years later. On the other hand, in the initial low risk group, 9 participants (5.4%) become high risk. Most of the participants did not change their risk group.

Furthermore, changes of each fall risk item were examined (Table 2). The proportion of participants who experienced a fall in the preceding year significantly declined within the high risk group, while there was no significant change in the low risk group. Within the low risk group, significant changes were found in items regarding "walking 1 km," "medication," "wearing sandals or slippers," and "anxiety about falling," and fall risk in these items increased. There was no item related to an increase of fall risk in the high risk group. Significant improvement in fall risk with "wearing sandals or slippers" was found in both fall risk groups.

Change characteristics in physical fitness

As shown in Table 3, a significant interaction was found only in the total score. Significant declines in grip strength and 6-minute walk were found in both risk groups. In both risk groups, physical fitness tended to decline three years later.

Change characteristics in ADL capability

Table 4 shows change in ADL capability. There was no significant interaction. In the low fall risk group, a significant decline was found within the 6 items of "walking," "jumping a ditch," "climbing up stairs," "standing from a sitting posture," "putting on pants or skirt while standing," "folding a futon," and total score. While in the high risk group, a significant decline in the ADL capability was found in only the three items of "walking," "jumping a ditch," and "putting on pants or skirt while standing," and in the total score. A significant decline in ADL capability was found in walking, maintaining and changing posture, and muscular strength within the low risk group, compared to the high risk group.

Discussion

This study followed fall risk and physical function for three

Table 4   Change characteristics in ADL capability

		The first year			The third year		2-way-ANOVA			Multiple comparisons
		N	Mean	SD	Mean		SD	F-value	*p*	
Walking	Low fall risk group	168	2.4	0.5	2.3	0.6	F1	16.3	0.000*	Low, High: 1st year>3rd year
	High fall risk group	29	2.2	0.6	1.9	0.6	F2	7.7	0.006*	
							F3	1.6	0.201	
Running	Low fall risk group	168	2.1	0.5	2.0	0.5	F1	7.1	0.008*	
	High fall risk group	29	1.7	0.6	1.5	0.5	F2	22.3	0.000*	1st, 3rd years: low>high
							F3	1.0	0.311	
Jumping the ditch	Low fall risk group	168	2.5	0.5	2.4	0.6	F1	12.7	0.000*	Low, High: 1st year>3rd year
	High fall risk group	29	2.3	0.6	2.1	0.6	F2	8.3	0.004*	
							F3	1.5	0.223	
Going up stairs	Low fall risk group	168	2.4	0.6	2.3	0.6	F1	6.3	0.013*	Low: 1st year>3rd year
	High fall risk group	29	2.1	0.7	2.0	0.6	F2	11.1	0.001*	
							F3	0.1	0.768	
Standing from sitting posture (Seiza)	Low fall risk group	168	2.6	0.5	2.5	0.5	F1	7.5	0.007*	Low: 1st year>3rd year
	High fall risk group	29	2.2	0.6	2.1	0.5	F2	18.6	0.000*	1st, 3rd years: low>high
							F3	0.2	0.663	
One foot balance with open eyes	Low fall risk group	168	2.5	0.6	2.4	0.6	F1	2.5	0.117	
	High fall risk group	29	2.0	0.6	2.0	0.4	F2	17.6	0.000*	1st, 3rd years: low>high
							F3	0.7	0.420	
Standing in the bus or train	Low fall risk group	168	2.4	0.5	2.3	0.5	F1	1.9	0.168	
	High fall risk group	29	2.0	0.5	2.0	0.5	F2	14.9	0.000*	1st year: low>high
							F3	1.9	0.168	
Putting on pants or skirt while standing	Low fall risk group	168	2.8	0.5	2.7	0.5	F1	18.0	0.000*	Low, High: 1st year>3rd year
	High fall risk group	29	2.4	0.8	2.1	0.7	F2	23.2	0.000*	1st, 3rd years: low>high
							F3	3.1	0.078	
Buttoning or unbuttoning a shirts	Low fall risk group	168	2.3	0.6	2.2	0.5	F1	7.9	0.005*	
	High fall risk group	29	2.1	0.7	1.9	0.6	F2	5.1	0.025*	
							F3	1.1	0.287	
Folding up and down a futons	Low fall risk group	168	2.7	0.5	2.5	0.5	F1	12.5	0.000*	Low: 1st year>3rd year
	High fall risk group	29	2.5	0.5	2.3	0.5	F2	5.9	0.016*	
							F3	0.6	0.427	
Carrying	Low fall risk group	168	2.5	0.5	2.4	0.5	F1	0.0	0.912	
	High fall risk group	29	2.1	0.6	2.2	0.6	F2	8.6	0.004*	1st year: low>high
							F3	3.7	0.056	
Sit-up	Low fall risk group	168	1.8	0.7	1.7	0.7	F1	4.2	0.042*	
	High fall risk group	29	1.5	0.6	1.3	0.5	F2	8.2	0.005*	
							F3	1.6	0.201	
General score	Low fall risk group	168	28.9	3.9	27.0	4.6	F1	34.7	0.000*	Low, High: 1st year>3rd year
	High fall risk group	29	25.0	4.6	23.3	4.5	F2	27.0	0.000*	1st, 3rd years: low>high
							F3	0.7	0.412	

Changes of each ADL item were evaluated by two-way repeated meaure ANOVA (fall risk group and pre-post change). F1: pre-post change, F2: fall risk group, F3: interaction,*: $p<0.05$.

years and compared changes between the low and the high risk groups. However, this study has a limitation in clarifying the effectiveness of exercise class participation on improvement of fall risk and physical functional characteristics, as it did not set a control group. Based on this limitation, we examined the possibility that a health promotion (community exercise class) implemented by the local government would contribute to the prevention of falls among the general community-dwelling

elderly.

In this study, a comparison of the change characteristics between high and low risk groups showed that the change in fall risk differed by fall risk level. In the high risk group, an improvement in the fall risk and fall incidence was found but none was found within the low risk group. These results may be attributed to the difference in the trend of change in physical function between the two fall risk groups.

Previous studies reported that a decline in walking ability and muscular strength and a subsequent decline of physical activity are serious risk factors for falls in the elderly population (Nevitt et al., 1989; Obuchi et al., 1994; Ryynänen et al., 1992; Yasumura et al., 1994). Significant improvement in physical function is recognized in successful intervention studies for fall prevention in the elderly (Barnett et al., 2003; Buchner et al., 1997; Campbell et al., 1997, 1999; Faber et al., 2006; Inokuchi et al., 2007; Lord et al., 1995; Robertson et al., 2001). The exercise class in this study was implemented by the local government to maintain and improve QOL and health status for the general community-dwelling elderly. It consists of various low-intensity exercises of tatami-walking, stretching, simple strength training, and recreational sports. These exercises may be lower in intensity and frequency than those of previous intervention studies (Barnett et al., 2003; Buchner et al., 1997; Campbell et al., 1997, 1999; Faber et al., 2006; Inokuchi et al., 2007; Lord et al., 1995; Robertson et al., 2001).

In this study, at onset, the physical function level was superior in the low risk group compared to the high risk group. In the low risk group, physical fitness and ADL capability decreased and the fall risk increased after three years. As in the case of the high fall risk group, it is unlikely that the exercise classes adversely affected the maintenance or improvement of physical function in the low risk group. These results obtained in the low fall risk elderly with high physical function suggest that the exercise intensity and frequency were too low to improve or maintain physical function of the low fall risk elderly. Therefore, the result in the low risk group is thought to be more influenced by aging.

In contrast, in the high risk group, ADL capabilities (walking, maintaining and changing posture, and muscular strength) were maintained and the fall risk was improved after three years. As also found in the low fall risk group, in general, physical function declines and fall risk increases with aging, and the same is equally true of the high fall risk group. The result found in the high risk group suggests the effect of continuous and regular participation in these exercises. It is meaningful that regular exercise may provide a positive effect on fall prevention for the general community-dwelling elderly who live independently. Furthermore, it is also meaningful that the community-dwelling elderly who live independently but have low physical function can safely continue these exercises for three years and prevent falls. It is important to develop and provide effective exercise programs that the elderly can safely, interestedly, and continuously implement.

The results obtained in this study suggest the following. First, even in the case of low risk elderly with high physical function, their fall risk increases within a few years. They regularly and continuously participated in the exercise class even if the programs were of low intensity and frequency. Despite this, their physical function also declined. Thus, it is easy to assume that the fall risk of the elderly without fitness habits rapidly increase with aging. It is necessary that prevention measures for these "low fall risk elderly" be assessed by cross-sectional screening.

Second, in the fall risk screening, assessments of fall risk and physical function are necessary, and exercise programs should be tailored to an individual's functional level. It appears to be a reality that there is no established exercise prescription, exercise volume (intensity, frequency, and duration) or exercise type (Carter et al., 2001), although previous studies have reported effective programs for fall prevention among the elderly (Gillespie et al., 2003; Province et al., 1995; Fiatarone et al., 1993; Hornbrook, et al., 1993). Further studies are required to develop effective programs applicable to the community-dwelling elderly.

Conclusions

By comparing change characteristics in fall risk and physical function between the high and low risk groups at the onset, an improvement in the fall risk was found in the high risk group. This may be attributed to the maintenance of walking ability and strength within the high risk group. A health promotion activity based on an exercise class implemented by the local government may successfully prevent falls among the general community-dwelling elderly by incorporating more diverse activities that are applicable to the physical function level of the targeted population.

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Appendix

Falling 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 told that you have diabetes?

    1. Yes; 0. No
10. Are you taking any sleeping drugs, blood pressure medicines 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 taking into consideration the corrections of native English speakers.