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Effects of Participation Frequency of Rehabilitation Classroom on Physical Functions and Their Sex-related Differences in Elderly Patients with Cardiac Diseases during Maintenance Period

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Abstract Effective exercise therapy in rehabilitation during maintenance period is important for the extension of life expectancy in the elderly patients with cardiac diseases. The effects of different participation frequencies in rehabilitation classes on physical functions in this cohort and their sex-related differences have been little examined. This study aimed to examine the effects of different participation frequency in rehabilitation classes on physical function, and sex-related differences. Participants were 167 elderly individuals with cardiac diseases during maintenance period (males, n = 78; mean age, 76.5 years; SD = 6.0 years; females, n = 89; mean age, 75.5 years; SD = 4.5 years) who registered for a 1-year twice a week exercise therapy program. They performed eight physical functioning tests 1 year later. Participants were classified into a low participation group that demonstrated <40% adherence (male, 17; female, 17) and a high participation group that demonstrated ≥70% adherence (male, 29; female, 46) based on participation rates in the exercise therapy program for 1 year. A significant interaction was found for one-legged balance with eyes open; this effect was stronger in the high participation group than in the low participation group in males, and higher in females than in males in the low participation group. Sit-ups and 6-min walking were superior in the high participation group compared with the low participation group. Males were superior in grip strength and sit-up. Females were superior in sitting trunk flexion. In conclusion, elderly patients with high participation frequency in rehabilitation classes were superior in muscle endurance and total endurance compared with those with low participation frequency. Males were superior in muscle strength and muscle endurance; females were superior in flexibility.

Keywords: *cardiac diseases, during maintenance period, participation frequency, physical function*

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1. Introduction

Several regional elderly people have a variety of diseases [1]. Recurrence prevention of cardiac diseases, which is one of three major diseases and is the second most common cause of death in Japan, is an important issue [2]. The regional elderly included elderly people with cardiac disease during maintenance period, after the acute stage or the recovery period in which physical function is reduced. They undergo rehabilitation, but do not require nursing care or support. Effective exercise therapy in rehabilitation during maintenance period is important for the extension of life expectancy. However, it has been reported that the effect on physical function differs based on the type, method, and frequency of exercise [3]. In addition, it has been reported that there are age- and sex differences in the rate of rehabilitation participation (participation frequency), and the participation frequency is lower in elderly individuals than in young individuals, particularly among elderly females [4,5]. Furthermore, Möller-Leimkühler [4] and Audelin et al. [5] reported that effects associated with convalescence are inferior in elderly females compared with elderly males, although they participate in the same exercise therapy class. Hence, females may exhibit inferior physical function to males during the maintenance period. There are reports that the improvement effect of exercise intervention is greater in individuals with high participation frequency than in those with low participation frequency in the regional-dwelling elderly [6,7], Nieuwland et al. [8] and Taaffe et al. [9] reported that participation at a low frequency can obtain similar effects to participation at a high frequency. Shigematsu and Nakanishi explained this discrepancy as follows: these

studies included only few cases and there were differences in the enforcement of exercise at home between studies [10].

Studies of physical function in the elderly during the maintenance period are scarce [11]. The effects of different participation frequencies in rehabilitation classes on physical function and sex-related differences have been little studied. Sugimoto et al. [12] examined gender differences in physical function in the elderly during the maintenance period and reported that they existed, but not in mobility and balance abilities. Sex-related may differ by participation frequency in rehabilitation classes.

This study aimed to examine the effects of different participation frequency in rehabilitation classes on physical function and the sex-related differences in the elderly during the maintenance period.

2. Methods

2.1. Participants

Participants included were 167 elderly individuals during maintenance period (males: n = 78; mean age, 76.5 years; SD = 6.4 years, females: n = 89; mean age, 75.5 years; SD = 4.5 years) who registered for regular exercise therapy twice a week for 1-year in Kyoto City. Participants with cardiac diseases had been stable for >6 months after disease development. They were all elderly (>65 years) and did not require nursing care or support. Their average participation rate in the exercise program was 60.3% ± 23.7%. Participants were classified into the low participation group with >40% (male: n = 17; mean age, 78.2 years; SD = 5.1 years, female: n = 17; mean age, 75.3 years; SD = 3.8 years), the intermediate participation group with 40%–69% (male: n = 32; mean age, 75.5 years; SD = 6.1 years, female: n = 26; mean age, 74.5 years; SD = 4.4 years), and the high participation group with ≥70% (male: n = 29; mean age, 76.6 years; SD = 6.4 years, female: n = 46; mean age; 76.1 years; SD = 4.8 years) based on participation rates in the exercise program for 1 year. The low participation group (average participation rate: male 26.8%, female 23.8%) registered with exercise program of twice a week, but attended it less than once a week on average. The high participation group (average participation rate: male 82.1%, female 82.8%) participated in almost all sessions. The exercise program mainly consisted of table tennis, aerobic exercise by an ergometer, and walking during every session. Participants underwent physical function tests (8 items) after attending regular exercise programs for 1 year. No participant with serious disease was contraindicated for exercises during tests. The aim of the study, measurement content, safety procedures, and the right to refuse the survey and tests on a voluntary basics were explained to participants. After receiving written informed consent from them, the tests were performed.

This study was approved by the Ethics Committee on Human Experimentation of the Faculty of Human Science, Kanazawa University (2012-27).

2.2. Rehabilitation Exercise Program

Group exercise therapy was a rehabilitation exercise program implemented during the maintenance period for patients with cardiac disease. It was designed to prevent illness recurrence and the need for care, to improve quality of life (QOL), and to extend healthy life expectancy [13]. This therapy is recommended for elderly individuals throughout their lifetime. Each exercise session lasted approximately 90 min and consisted of the following: a 15-min warm-up, 6-min walking, 50-min main exercise (table tennis, soft tennis, or bicycle ergometer), and 15-min cooling down. The exercise program was controlled according to individual physical function level in this study.

2.3. Measurement Items and Procedure

1) Physique measurement

Physical characteristics measured were as follows: height, weight and body fat percent. Weight and body fat percent were measured using a body fat calculator (BC-118, TANITA Co., Ltd., Japan).

2) Physical function items

The most importance for understanding the physical function of the elderly is to comprehensively evaluate physical function elements [14]. The new fitness test designed by the Ministry of Education, Culture, Sports, Science and Technology comprehensively evaluates physical fitness using six items representing each physical fitness factor. This test has been performed on a national scale, and all items have high reliability [15]. We used two items of the Timed Up & Go (TUG: movement ability) and stepping (agility) performed in a sitting position on the chair, in addition to the above stated six items. The TUG test is a standard test used to determine the effect of exercise classes, and the stepping test is used for assessing fall risk [16,17]. Both items can be safely and easily performed in a short time and we can facilitate to accurately understand the physical function of the elderly [17,18]. Briefly, the following eight tests were selected in this study: grip strength, 10-m obstacle walking time, one-legged balance with eyes open, sit-ups, sitting trunk flexion, 6-min walk, stepping, and TUG. Grip strength of the right and left hands was measured twice in a standing position using a Smedley's hand dynamometer (TKK5401, Takei Scientific Instruments Co., Ltd., Japan), and the average of the larger values was used as a representative value. Sitting trunk flexion was measured twice using a trunk flexion instrument (EKJ091, EverNew Co., Ltd., Japan), and the larger value was used for analysis. Stepping was determined as the number of times a subject stepped from inside to outside two lines placed 30 cm apart with both legs, in a sitting position for 20 s [17]. The TUG test was measured as the time required to walk to a cone 3 m away after starting from a sitting position and to return to the original seated position [16]. The method of measurement for all physical function tests, except for the stepping and TUG tests, was based on the Implementation Guidance of the Ministry of Education [15].

2.4. Statistical Analysis

Statistical analysis was performed using SPSS 11.5J for Windows (SPSS Inc., Tokyo, Japan). Data from the low participation group (n = 34) and high participation group (n = 75), but not from the intermediate participation group

were used. Each measured value is presented as mean and standard deviation based on sex and participation frequency. A two-way ANOVA with unpaired measures was used to examine significant mean differences (sex × participation frequency) for the physical function tests. When significant interactions or main effects were found, a multiple-comparisons test was conducted using Tukey's honestly significant difference method. An alpha level of 0.05 was considered to be significant for all tests. Further, the size of the effect (eta squared: η2) was calculated to examine the size of the mean difference. The effect amount (the eta was identical: η2) was interpreted with reference to the report of Mizumoto and Takeuchi [19] as follows: 0.01 was considered to be small, 0.06 moderate, and 0.14 large.

3. Results

Table 1 shows the means, standard deviations, and results of a two-way analysis of variance (ANOVA) for age, physical characteristics (height, weight, and body fat percentage) according to sex and participation rate. Significant interaction was found in weight, and it was greater in males than in females in the low participation group. The height was greater in males and in the high participation group. The body fat percentage was higher in females than in males. Age showed no significant main effect in both factors of sex and participation rate.

Table 2 shows the means and standard deviations for each physical function variable according to sex and different participation frequencies and results of a two-way (ANOVA) and a multiple-comparison test. A significant interaction was found in the one-legged balance with eyes open test ($F = 7.35$, $p < 0.05$). Results on the test were higher in the high participation group than in the low participation group among males, and higher in females than in males in the low participation group. TUG ($F = 4.39$, $p < 0.05$) showed a significant main effect of group: speed was faster in the high participation group than in the low participation group in both sexes. Grip strength ($F = 93.93$, $p < 0.05$), sitting trunk flexion ($F = 9.54$, $p < 0.05$) and stepping ($F = 4.01$, $p < 0.05$) showed significant main effects with regard to sex. Grip strength was greater in males than in females in both groups. Sitting trunk flexion and stepping results were higher in females than in males. The other items showed significant main effects of both factors. Number of sit-ups (sex: $F = 13.30$, $p < 0.05$, group: $F = 7.57$, $p < 0.05$) and distance in the 6-min walk (sex: $F = 4.70$, $p < 0.05$, group: $F = 9.96$, $p < 0.05$) were higher in the high participation group than in the low participation group in both sexes and higher in males than in females in both groups. The 10-m obstacle walking time (sex: $F = 4.59$, $p < 0.05$, group: $F = 5.19$, $p < 0.05$) was faster in the high participation group than in the low participation group in both sexes and higher in males than in females in both the low and high participation groups. With regard to the participation frequency factor, the effect size was medium (η2: 0.07–0.9) for sit-ups and 6-min walk tests and small (η2: 0.04–0.05) for 10-mobstacle walking time and TUG. With regard to sex, effect size was large (η2: 0.47) for grip strength, medium (η2: 0.07–0.09) for sit-ups and sitting trunk flexion and small (η2: 0.04–0.05) for the other items.

Table 1. Means, standard deviation of physical characteristics of participants by gender and group, results of two-way analysis of variance and multiple comparisons

		Low group			High group			Two-way ANOVA				Multiple comparison
		N	Mean	SD	N	Mean	SD		df	F	p	η^2	
Age (years)	Male	17	78.2	5.1	29	76.6	6.4	Sex	1	2.68	0.10	0.03	
	Female	17	75.3	3.8	46	76.1	4.8	Group	1	0.14	0.71	0.01	
								Interaction	1	1.20	0.28	0.01	
								Error	105				
Height (cm)	Male	17	160.6	4.2	29	161.9	5.6	Sex	1	73.06*	0.01	0.41	Male>Female
	Female	17	150.1	3.9	46	154.7	5.2	Group	1	7.85*	0.01	0.07	Low<High
								Interaction	2	2.36	0.13	0.02	
								Error	105				
Weight (kg)	Male	17	63.5	6.2	29	56.8	6.1	Sex	1	29.50*	0.01	0.22	Males: Low>High
	Female	17	50.7	8.4	46	54.8	6.1	Group	1	0.95	0.33	0.01	
								Interaction	1	15.62*	0.01	0.13	Low: Male>Female
								Error	105				
Percent body fat (%)	Male	15	25.7	4.7	29	21.9	5.5	Sex	1	41.68*	0.01	0.30	Male<Female
	Female	16	32.8	7.5	42	33.6	7.7	Group	1	1.08	0.30	0.01	
								Interaction	1	2.38	0.13	0.02	
								Error	98				

note) M: Mean, SD: standard deviation, df: degree of freedom, η2: effect size, *: p<0.05.
Male>Female: Male shows significantly larger results than female.
Male<Female: Female shows significantly larger results than male.
Low<High: The high group shows significantly larger results than the low group.
Low>High: The low group shows significantly larger results than the high group.

Table 2. Means, standard deviations of physical function tests by gender and group, results of two-way analysis of variance and multiple comparisons

		Low group			High group				Two-way ANOVA				Multiple comparison
		N	Mean	SD	N	Mean	SD		df	F	p	η^2	
Grip strength(kg)	Male	17	31.0	3.7	29	30.2	5.2	Sex	1	93.93*	0.01	0.47	Male>Female
	Female	17	21.4	4.0	46	21.8	4.4	Group	1	0.07	0.80	0.01	
								Interraction	1	0.38	0.54	0.01	
								Error	105				
Sit-ups(point)	Male	17	4.5	4.8	29	8.9	4.8	Sex	1	13.30*	0.01	0.11	Male>Female
	Female	17	2.7	3.6	46	3.6	4.8	Group	1	7.57*	0.01	0.07	Low<High
								Interraction	1	3.29	0.07	0.03	
								Error	105				
Sitting trunk flexion (cm)	Male	17	26.0	11.8	29	27.9	8.7	Sex	1	9.54*	0.01	0.08	Femalw>Male
	Female	17	33.4	6.1	46	32.0	8.6	Group	1	0.02	0.89	0.00	
								Interraction	1	0.81	0.37	0.01	
								Error	105				
One-legged balance with eyes open(sec)	Male	17	33.2	34.9	29	64.3	47.3	Sex	1	0.40	0.53	0.01	Male: Low<High
	Female	17	64.1	52.6	46	45.1	42.0	Group	1	0.42	0.52	0.01	Low: Female>Male
								Interraction	2	7.35*	0.01	0.07	
								Error	105				
10-m obstacle walking time(sec)	Male	17	7.6	2.3	29	6.2	1.0	Sex	1	4.59*	0.04	0.04	Female>Male
	Female	17	7.7	1.7	46	7.5	1.6	Group	1	5.19*	0.03	0.05	Low>High
								Interraction	1	3.16	0.08	0.03	
								Error	105				
6-min walk(sec)	Male	16	534.1	66.7	29	580.2	66.5	Sex	1	4.70*	0.03	0.05	Male>Female
	Female	15	501.3	83.2	42	548.8	64.8	Group	1	9.96*	0.01	0.09	Low<High
								Interraction	1	0.10	0.96	0.00	
								Error	98				
Timed up & go (sec)	Male	17	6.6	1.3	29	5.8	0.8	Sex	1	0.03	0.86	0.01	Low>High
	Female	17	6.3	0.9	46	6.2	1.1	Group	1	4.39*	0.04	0.04	
								Interraction	1	2.94	0.09	0.03	
								Error	105				
Stepping by sitting position (point)	Male	17	30.8	5.4	29	31.9	5.8	Sex	1	4.01*	0.04	0.04	Female > Male
	Female	17	32.9	5.7	46	33.8	3.7	Group	1	0.91	0.34	0.01	
								Interraction	1	0.01	0.91	0.00	
								Error	105				

note, M: Mean, SD: standard deviation, df: degree of freedom, η2: effect size, *: p<0.05
Male>Female: Male shows significantly larger results than female.
Female<Male: Female shows significantly larger results than male.
High>Low: The high group shows significantly larger results than the low group.
Low>High: The low group shows significantly larger results than the high group.

4. Discussion

Grip strength and sit ups representing muscle strength and muscle endurance, respectively, were superior in males compared with females in both low and high participation groups. In addition, sit ups was superior in the high group compared with the low groups in both sexes. It was reported that they are superior in males compared with those in females in several studies [20,21]. Barnett et al. [22] examined the improvement in balance ability, reaction time, and walking speed following a nursing prevention physical program targeting various regional-dwelling elderly individuals at a risk of fall. The program was attended once a week for 1 year and the results indicated that the group that attended all sessions only improved with regard to balance ability compared with the group that attended very few sessions. The authors concluded that grip strength was not affected by a difference in

participation frequency because participants frequently used hands and arms in daily life. However, a sit-up, a movement that raises the upper body from a supine position so that both elbows contact both femoral regions while knees are bent at 90°, is not performed in daily life. Repeated practice exerting the muscle strength of the trunk is required for improvement on this task [15,23]. The high participation group had much more opportunity to use the muscles of the upper body in the rehabilitation classes compared with the low participation group. This may explain the finding of a significant difference in sit-up performance.

Sitting trunk flexion, representing flexibility, showed only sex-related differences, and it was superior in females in both the low and high participation groups. Flexibility is generally superior in females [24]. Sugimoto et al. [25] examined change in physical function following a rehabilitation exercise program during the maintenance period twice a week for 1 year and reported that flexibility was superior in females compared with males and that an exercise effect after 1 year was not found in both sexes. In addition, Sugimoto et al. reported that the exercise program for rehabilitation during the maintenance period including aerobic exercise, table tennis, and soft tennis could not suppress a decrease in flexibility with age [12]. In short, even if elderly patients with cardiac diseases during the maintenance period attend rehabilitation classes for 1-year, flexibility may not be affected by a difference in participation frequency.

One-legged balance with eyes open, representing balance ability, was superior in the high participation group compared with the low participation group in males, and superior in females than in males only in the low participation group. In short, the results of one-legged balance with eyes open suggest that males are affected by participation frequency more than females. Sugimoto et al. [12] reported that the exercise intensity of rehabilitation classes during the maintenance period is more suitable for females than for males, and that decreases in the balance ability of females may be suppressed. Hence, we consider that the high participation group actively participating during the maintenance period rehabilitation exercise program did not show sex-related differences in balance ability. Further research is required to examine this finding based on longitudinal data.

The 6-min walk, representing total endurance, was superior in the high participation group compared with the low participation group in both sexes. Kinugasa et al. [26] divided the elderly with low physical fitness (Tokyo Metropolitan Institute of Gerontology (TMIG) Index of Competence) at random into an intervention group (aerobics, strength exercise, and stretching twice a week) and a control group (monthly aerobics and stretching once a month), and examined the effect of exercise, reporting that the former improved total endurance compared with the latter after 6 months. Tsuji et al. [27] conducted a randomized controlled study targeting cardiac disease in elderly individuals (n = 65), and reported that the group that continued aerobics exercise and muscle training for 2 h a day twice a week for 25 weeks increased maximum oxygen uptake and were 5 years younger in total endurance than the group that did not exercise. Consistent with the present results, it was clear that endurance was superior in elderly patients with cardiac disease during the maintenance period who actively participated in rehabilitation, compared with the group that hardly participated. Sugimoto et al. [25] examined the changes in physical function targeting elderly individuals with cardiac disease during the maintenance period (n = 29, average age males: 74.1 years, females: 74.0 years) twice a week for 1 year, reporting that results for 10-m obstacle walking time, TUG, 6-min walk, and stepping in a sitting position did not show sex-related differences. [24] In the present results, all of these items, except for TUG, showed sex-related differences; however, the effect size was small ($\eta 2$: 0.04–0.05). Although the elderly with cardiac diseases during the maintenance period attended the rehabilitation classes for 1 year, it is possible that the effects of participation frequency on walking ability and movement ability would be small and that the effects on walking ability, endurance, and agility would be similar in males and females. This study was limited by the possibility that elderly patients who registered to participate in classes were already relatively active in daily life. Further, when examining the difference in physical function according to participation frequency, we did not consider factors such as activities of daily living, life activity amount, and walking ability. In future research, it will be necessary to examine the effects on physical function while considering differences in the abovementioned factors or in the means of movement by which they attend rehabilitation classroom.

5. Conclusion

In conclusion, elderly individuals with cardiac disease during the maintenance period who participated more frequently in rehabilitation programs exhibited superior muscle endurance and total endurance than those who participated less frequently. In addition, males were superior with regard to muscle strength and muscle endurance, and females were superior with regard to flexibility.

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