ORIGINAL PAPER

Nagoya J. Med. Sci. **71**. 115 ~ 126, 2009

CHANGES IN ACTIVITIES OF DAILY LIVING, PHYSICAL FITNESS, AND DEPRESSIVE SYMPTOMS AFTER SIX-MONTH PERIODIC WELL-ROUNDED EXERCISE PROGRAMS FOR OLDER ADULTS LIVING IN NURSING HOMES OR SPECIAL NURSING FACILITIES

PEI OUYANG, HIROSHI YATSUYA, HIDEAKI TOYOSHIMA, REI OTSUKA, KEIKO WADA, KUNIHIRO MATSUSHITA, MIYUKI ISHIKAWA, LI YUANYING, YO HOTTA, HIROTSUGU MITSUHASHI, TAKASHI MURAMATSU, NORIKATSU KASUGA and KOJI TAMAKOSHI

Department of Public Health/Health Information Dynamics, Field of Social Life Science, Nagoya University Graduate School of Medicine

ABSTRACT

A 6-month, twice weekly, well-rounded exercise program (47 sessions in total) comprised of a combination of aerobic, resistance and flexibility training was provided for institutionalized older adults aged 60 to 93. We analyzed the data of 18 older adults who could stand and had attended more than 10% of the classes (mean participation rate: 54%) to examine changes in activities of daily living (ADL), physical fitness tests and depressive moods. The mean (± standard deviation, range) age of the participants was 71.3 (±15.6, 60–93) in men and 85.9 (±5.8, 72–93) in women. Significant improvement in ADL of the hand manipulation domain and borderline significant improvement in ADL of the mobility domain were observed (McNemar test p=0.011 and 0.072, respectively). A 6-minute walk distance increased significantly from 151.6 m to 236.6 m (p=0.01, paired t-test), and the result of the Soda Pop test, which tests hand-eye coordination, also improved significantly from 35.2 sec to 25.3 sec (p=0.01, paired t-test). These findings suggest that such a program could be effective in improving the ADL and physical fitness of the elderly.

Key Words: Older adults, Well-rounded exercise program, Activities of daily living, Physical fitness

INTRODUCTION

Japan is facing severe and rapid population aging such as no country has ever experienced.[1] The current social security scheme that financially depends on the younger generation would not be sustainable if the number of frail elderly continues to rise as steeply as we have already experienced.[2,3] It has been realized that reducing the need for long-term care by targeting the elderly with a strategy to strengthen and maintain their residual functions is important.[4]

Corresponding author: Hiroshi Yatsuya
Department of Public Health/Health Information Dynamics, Field of Social Life Science,
Nagoya University Graduate School of Medicine, 65 Tsurumai-cho, Showa-ku, Nagoya 466-8550, Japan
Phone: +81-52-744-2128, Fax: +81-52-744-2131, E-mail: h828@med.nagoya-u.ac.jp

Preventing elderly people from becoming limited in performing activities of daily living (ADL) is also an important health objective for maintaining their quality of life.[5]

More and more attention has been paid to devising measures for preventing a decline in muscle strength in an attempt to reduce the burden of long-term care since muscular atrophy due to disuse, a consequence of an inactive life, plays an important role in the progression of frailness.[6] Recently, multifactorial intervention that targets balance, strength, endurance, or flexibility was reported to be highly effective for the prevention of falls and injuries in older adults.[7] Concurrent aerobic and resistance or flexibility exercises, *i.e.* a well-rounded exercise program (WREP), were reported in Japan to improve the fitness of the elderly.[8] There is relatively limited evidence regarding the late elderly or institutionalized elderly,[9-12] especially in Japan where preventive programs targeting the pre-frail elderly to maintain their independence have been promoted by the nursing care insurance system. There are also uncertainties regarding the ideal duration, frequency, or content of such programs.[7,13] Furthermore, the prospective association between WREP and depression is unresolved. In this study, we attempt to address some of these issues by assessing differences in ADL, physical fitness and depressive symptoms before and after periodic WREP classes to infer whether combined exercise intervention may be effective in improving physical performance and mental well-being in the elderly living in nursing homes or special nursing facilities.

METHODS

Participants

The present study utilized the data collected during exercise programs conducted as part of the activities of a social welfare enterprise. In 2003, 28 elderly, aged 60 to 93, who could stand and who had lived or been institutionalized either in a nursing home (n=11) or in a special nursing facility for the frail elderly (n=17), were included in the study. Both facilities were located in the same building and owned by a social welfare enterprise. Participation in the classes was completely voluntary, and verbal informed consent was obtained from both participants and their families. Ten subjects who attended the classes 10% of the time or less were excluded, leaving 18 subjects for the present analysis (mean participation rate: 54%) including 11 elderly institutionalized in the special nursing facility. All 18 subjects had answered both the baseline and post-WREP ADL questionnaire-based interviews; however, four did not undergo post-WREP physical fitness tests. The study procedure, including the use of secondary data for epidemiologic research, was approved by the Ethics Review Committee of the Nagoya University School of Medicine.

Exercise program

A well-rounded exercise program (WREP) consists of resistance, aerobic and flexibility training. In the present WREP, to ensure the safety of the elderly, exercises were designed that could be performed while seated and at 30–50% of maximum heart rate, which had been estimated from baseline physical fitness test result. One interventionist (licensed exercise trainer), one chief care worker, one clerk, one to two care workers or nurses, and one to two volunteers were involved in the program. We had also prioritized low-cost exercises as well as those that were fun. The class was held twice a week over a period of six months (47 sessions in total). The duration of each class began at 30 minutes, but was gradually increased based on improvements in physical strength and endurance (120 minutes maximum). Activities such as participating in games were included in each session aimed at producing beneficial psychological effects. The

Table 1 Baseline characteristics of participants according to types of facility and age groups

Variables	Total (n=18)	Types of facility		Age groups	
		Special nursing facilities for elderly (n=11)	Nursing homes (n=7)	75 years or older (n=14)	60~74 years old (n=4)
M/F (n)	4/14	4/7	0/7	1/13	3/1
Age (years old)	82.7 ± 10.4	82.3 ± 12.4	83.3 ± 7.2	87.4 ± 4.6	66.0 ± 6.9
Height (cm)	145.2 ± 10.2	147.5 ± 12.0	141.6 ± 5.6	140.6 ± 4.5	161.1 ± 8.1
Weight (kg)	49.2 ± 7.7	50.4 ± 9.0	47.0 ± 5.0	48.1 ± 7.5	53.8 ± 8.2
Body mass index (kg/m^2)	23.4 ± 3.1	23.6 ± 3.5	23.2 ± 2.8	24.1 ± 3.1	20.6 ± 1.0
ADL score	17.1 ± 7.0	16.1 ± 7.5	18.6 ± 6.3	15.6 ± 5.7	22.3 ± 9.6
CES-D score	8.8 ± 8.1	10.5 ± 8.4	6.3 ± 7.4	6.9 ± 6.5	15.8 ± 10.3

n indicates number; M, male; F, female; ADL, Activities of Daily Living; CES-D, Center for Epidemiologic Studies Depression scale.
Values are presented as means±standard deviation.
Body mass index is calculated as weight (kg) divided by (height (m))^2.

types of exercise were selected according to the following considerations. (1) Dance, cycle ergometers and walking were included for endurance improvement. (2) Resistance training, elastic band-based training, and dumbbell training were aimed at increasing the muscular strength of limbs. (3) Flexibility exercises, stretching, rhythmic exercises, Proprioceptive Neuromuscular Facilitation (PNF), Tai Ji Quan (Tai Chi Chuan), and finger exercises were performed for the improvement of flexibility and adjustment ability. (4) The control of small joints was stimulated through participation in games.

Activities of daily living (ADL) questionnaire

The ADL level was assessed by a structured interview using a 12-item questionnaire, which had originally been introduced by the Japanese Ministry of Education, Culture, Sports, Science and Technology for the assessment of the elderly, with minor modifications (Table 2).[14] A single examiner (a care worker of the facility) assessed all the participants to avoid evaluation differences between testers. In this study, four domains of ADL were defined: (I) mobility and walking assessed by items Q1, Q2, Q3, Q4 and Q11, (II) hand manipulation assessed by items Q9 and Q10, (III) balance assessed by items Q6, Q7 and Q8, and (IV) changing posture by items Q5 and Q12. Each item uses three or four ordinal scales, and we assigned a score ranging from 1 to 4 according to the response. The composite score for each domain was then calculated as the sum of each item score.

Anthropometry and blood analysis

Height and body weight were obtained, and the percentage of body fat was estimated by an impedance method (body fat analyzer, TBF-305; Tanita, Tokyo, Japan). Body mass index (BMI) was calculated as the weight (kg) divided by the square of height (m). Blood pressure was measured in a sitting position by an automatic sphygmomanometer by the oscillometric method. We have acquired blood analysis data that were obtained as a part of the participants' health check-up by the facility. Thus, post-WREP blood analyses were not actually carried out right after the class.

Physical fitness tests

1. Handgrip force

The peak handgrip force of each hand was determined by a Smedley-type hand dynamometer

Table 2 Comparisons of ADL between baseline and after six months of classes

ADL items		Baseline (pre-WREP)	post-WREP				p
			1	2	3	4	
Q1 How long can you walk without a rest?	1	Not at all		3			0.23
	2	5 to 10 min		3	5	1	
	3	20 to 40 min		2	1		
	4	more than 1 hr				3	
Q2 How long can you run without a rest?	1	Not at all	15	1			1
	2	3 to 5 min	1				
	3	more than 10 min		1			
Q3 Could you jump over a ditch that is about:	1	Cannot jump over any length	6	5	1		0.050
	2	30 cm long		4			
	3	50 cm long			2		
Q4 How easily can you climb stairs?	1	Cannot climb stairs at all		1			1
	2	Only with banisters or wall		8	2		
	3	Slowly without banisters or wall		2	4		
	4	Normal pace without any assist				1	
Q5 How easily can you stand up from sitting on the ground?	1	Not at all	8	3			0.32
	2	Need to use hands	1	3			
	3	Without using hands			3		
Q6 How long can you stand on one leg with your eyes open?	1	Not at all	9	6	1		0.030
	2	10 to 20 seconds		1			
	3	more than 30 seconds			1		
Q7 Could you keep standing during a bus or train ride?	1	No	7	7			0.008
	2	Only if assisted by banisters or strap		3			
	3	Can do without any assistance except for departure or stopping			1		
Q8 Can you put on pants or skirt while standing?	1	No		1			0.37
	2	Not unless seated		6	3		
	3	Only if holding onto something		1	2		
	4	Can do without assistance			1	4	
Q9 Can you fasten or loosen the front buttons of your shirts?	1	No	1				0.037
	2	Slowly using both hands		4	6		
	3	Quickly using both hands		1	1	3	
	4	Quickly with only one hand				2	
Q10 Can you take out or put in a set of futons from (into) a sliding-door closet?	1	No	4	6	1		0.046
	2	Only blanket or light futon		3	1		
	3	Easily even heavy futon			3		
Q11 Could you carry an item if it weighs about:	1	Cannot carry any such weight	6	5			0.025
	2	5 kg		5			
	3	10 kg			2		
Q12 How many times can you sit up without using your hands?	1	None	12	1			0.37
	2	1 to 2 times					
	3	more than 3 to 4 times	1	1	3		

p values by McNemar tests.
Shaded cells indicate no change. Upper right cells indicate improvement.

(ST100 T1780, Toei Light Co., Ltd., Tokyo). Trials were repeated twice for each hand, and the mean value of the two trials was used for the analysis.

2. Sit and reach test

The sit and reach test was performed to evaluate the flexibility of the subject's trunk using a box-type sit and reach apparatus (Toei Light T-284). The subjects were instructed to sit with their feet positioned flat against the apparatus, with knees fully extended and legs aligned together. As the examiner pressed down on the knees to keep them extended, subjects were instructed to stretch forward slowly with hands and arms outstretched as far as possible toward or past the toes for at least 1 second. Two trials were administered; and the better (longer) measurement reached was recorded.

3. Stork stand (eyes open)

Subjects were instructed to stand on one bare foot and to maintain that posture as long as possible up to 120 seconds. Two trials were performed, and the longer duration was recorded.

4. Soda Pop test

This test was designed to evaluate a subject's hand-eye coordination skill.[15] Three soda cans were placed on the examination table. Subjects were instructed to grasp one can with the dominant hand. On a verbal signal from the examiner, the subject turned one can upside down and proceeded to the next can. After the third can was inverted, the participant returned to the first can, replaced it in the original position and proceeded to the other two cans. The time needed to complete the procedure was recorded. The trial was given twice, and the shorter time was obtained.

5. 6-minute walk

Subjects were instructed to walk in a straight line between two chairs positioned 20 meters apart. They were then told to change direction at the chair and to walk back. Only one trial was allowed for each subject. Total distance walked was recorded.

6. Catching a ruler (Yardstick test)

The examiner held a pole-shaped ruler vertically (ruler, T.K.K.5008, Takei Scientific Instruments Co., Ltd., Niigata) near the 50 cm mark until the subject was ready to place but not touch the bar with the thumb and the index finger at the 0 cm level (the bar weighed 115 g). The examiner then let the bar drop while the subject tried to catch it as quickly as possible. No signal was given to the subject when the bar would be dropped. The level in cm just above the subject's first finger where the bar was caught was recorded. The same subject was tested twice, and the mean value was recorded to represent the subject's reaction time.[15]

7. 10-m obstacle walk

Subjects were instructed to walk 10 m in a straight line along which six obstacles 20 cm in height, 10 cm in length and 50 cm in width had been placed at two-meter intervals including a start and a finish point. Subjects performed the trial twice, and the better time was recorded.

Depression scale

The Center for Epidemiologic Studies Depression Scale (CES-D) was used to evaluate depressive symptoms of the elderly.[16] It contains 20 items that inquire into the frequency of a symptom or mood an examinee experienced during the previous week. Scoring for positively worded items has been reversed so that high scores represent responses in the depressed range.

Statistical analysis

All statistical analyses were performed with SPSS for Windows. A p-value of less than 0.05 was considered statistically significant. Continuous and categorical variables were tested for the differences between the baseline and post-WREP classes by paired t-test and McNemar tests.

After assessing the changes in each ADL questionnaire item, changes in the composite scores of four ADL domains and the overall total score were examined. Participants were first categorized into tertiles according to the rank distribution of their baseline ADL scores. The post-WREP scores were divided into three categories using the cutoff-points of each baseline ADL tertile. If there were rows or columns in the contingency tables comparing baseline versus post performance of each ADL item in which no participants had been included, we attempted to run the McNemar test by putting one participant into the diagonal cell which would have represented “no change” in that row (or column). Changes in the Soda Pop test and 6-minute walk distance tests were performed by stratifying the subjects by the participation rates in the WREP classes; 50% or more (n=10) and 10 to 49% (n=8), although four participants in the latter group did not undergo the post-WREP physical fitness tests.

RESULTS

The mean age (± standard deviation, range) of the participants was 71.3 (±15.6, 60–93) for men and 85.9 (±5.8, 72–93) for women (Table 1). The proportion of women and of those aged 75 or over were both 77.8%. The average BMI was 23.4 (±3.1) kg/m^2, with 25% of the subjects exceeding 25 kg/m^2. The mean ADL score was 17.1 (±7.0) out of a possible 36. The scores of subjects in a special nursing facility (16.1) and of those aged 75 or over (15.6) were lower than the scores of those in a nursing home (18.6) or those aged 60 to 74 (22.3), respectively, but the differences were not statistically significant. The mean CES-D was 8.8, with that of those aged 60 to 74 (15.8) being higher than that of those 75 or over (6.9).

There were statistically significant or borderline significant differences in ADL questionnaire items Q3 (p=0.050), Q6 (p=0.030), Q7 (p=0.008), Q9 (p=0.037), Q10 (p=0.046), and Q11 (p=0.025) (McNemar tests) (Table 2). Out of four ADL domains, that of hand manipulation and mobility improved (p=0.011 and p=0.072, respectively, McNemar tests) (Table 3). For example, in mobility ADL, among eight elderly in the first tertile (T1), three moved to the second tertile (T2) after the class, while two moved to the third (T3). Two participants who had been in T2 before the class were advanced to T3 after the class. We analyzed the total ADL score in the same manner, *i.e.* four out of seven and three out of six participants who had been in T1 or T2 before the class advanced to T2 or T3, respectively, after the class (p=0.030, McNemar test) (data not shown in the table).

Mean performance of the elderly in the 6-minute walk increased significantly from 151.6 m to 236.6 m (p=0.01, paired t-test) (Table 4). Similarly, the mean performance of Soda Pop tests also improved significantly from 35.2 to 25.3 seconds (p=0.01, paired t-test). As for the anthropometric and blood analyses, body fat was significantly reduced (–1.2 kg, p=0.040, paired t-test), though BMI did not change (p=0.62). On the contrary, total cholesterol levels increased by 9.4 mg/dl (p=0.040 paired t-test). Both systolic and diastolic blood pressure declined 7.7 and 8.1 mmHg on average, respectively, with the latter difference proving statistically significant (p=0.04, paired t-test).

Two out of the four participants who had been considered depressive based on CES-D scores of 16 points or over before the class were no longer depressive after the class, though the difference was not significant (p=0.75, McNemar test).

When we stratified the participants according to their participation rates in the program, both high-rate (50% or more) and low-rate (10 to 49%) participants tended to improve their performance in the Soda Pop test and the 6-minute walk distance (Fig. 1), though the statistical significances were attenuated to some extent. High-rate subjects achieved significantly longer

Table 3 Comparisons of ADL in four domains between and after six months of classes

Domains	post-WREP*			
Baseline (pre-WREP)*	T1 (lowest)	T2	T3 (highest)	*p*
Mobility and walking				
T1 (lowest)	3 (37.5)	3 (37.5)	2 (25.0)	
T2	0	4 (66.7)	2 (33.3)	0.072
T3 (highest)	0	0	4 (100)	
Manual activities, dressing and bathing				
T1 (lowest)	3 (33.3)	6 (66.7)	0 (0.00)	
T2	0	3 (50.0)	3 (50.0)	0.011
T3 (highest)	0	0	3 (100)	
Balance				
T1 (lowest)	4 (44.4)	1 (11.1)	4 (44.4)	
T2	1 (33.3)	0	2 (66.7)	0.112
T3 (highest)	0	0	6 (100)	
Changing and maintaining posture				
T1 (lowest)	7 (77.8)	2 (22.2)	0	
T2	1 (33.3)	2 (66.7)	0	0.513
T3 (highest)	0	1 (16.7)	5 (83.3)	

*: Participants were first categorized into tertiles according to the rank distribution of their baseline ADL scores. The post-WREP scores were divided into three categories using the cutoff-points of each baseline ADL tertile.
Numbers indicates the number of subjects (percentage among row total).
p value by McNemar tests.
Movement is assessed by Q1, 2, 3, 4, and 11. Manual activities, dressing and bathing by Q9 and 10.
Balance by Q6, 7, and 8. Changing and maintaining posture by Q5 and 12.

Table 4 Comparisons of anthropometric and laboratory test, and physical fitness tests before and after classes

	Baseline (pre-WREP)	post-WREP	Difference	SE of difference	95% CI		*p*
Anthropometric and laboratory tests							
SBP (mmHg)	141.5	133.8	–7.7	6.7	–21.8	6.4	0.27
DBP (mmHg)	74.8	66.0	–8.8	4.0	–17.2	–0.4	0.040
BMI (kg/m^2)	23.4	23.3	–0.1	0.2	–0.6	0.4	0.62
Body fat (kg)	18.0	16.8	–1.2	0.5	–2.3	–0.1	0.040
Hemoglobin (g/dl)	12.3	12.2	–0.1	0.1	–0.3	0.2	0.47
Hematocrit (%)	36.2	36.3	+0.1	0.3	–0.6	0.8	0.73
Red cell blood count (/mm^3)	380.1	382.3	+2.3	3.4	–4.8	9.4	0.50
Total cholesterol (mg/dl)	193.0	202.4	+9.4	4.3	0.4	18.5	0.040
Physical function tests							
Handgrip force right (kg)	14.3	14.2	–0.1	1.5	–3.3	3.0	0.92
Handgrip force left (kg)	14.3	14.4	+0.1	1.1	–2.4	2.5	0.95
Sit and reach (cm)	25.4	28.7	+3.3	3.7	–4.6	11.2	0.38
Soda pop time (sec)	35.2	25.3	–9.9	3.4	–17.3	–2.4	0.010
Catching a ruler (cm)	39.5	34.9	–4.5	3.9	–13.0	3.9	0.27
6–minute walk distance (m)	151.6	236.6	+85.0	29.2	21.9	148.1	0.010
Stork stand (eyes open) (sec)	2.6	2.6	0	0.7	–1.4	1.4	0.99
10-m obstacle walk (sec)	14.4	12.2	–2.2	3.3	–9.3	4.8	0.50

SE indicates standard error; CI, confidence interval; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index.
p-values by paired t-test

6-minute walk distance at baseline than low-rate participants (p=0.002, independent t-test).

In addition, analyses excluding those aged 60 to 74 did not materially alter the present findings (data not shown).

DISCUSSION

After a six-month program of aerobic, resistance and flexibility exercises, ADL of the hand manipulation domain improved significantly, as did that of the mobility domain borderline. There were also significant improvements in the performance of the Soda Pop test and 6-minute walk distance. Improvements in these physical fitness tests were thought to correspond to improvements in the ADL domains.

The improvements of the ADL in hand manipulation and mobility were considered appropriate since the exercises we emphasized were those for strengthening both the upper and lower limbs using elastic bands and dumbbells. Furthermore, we employed recreational activities that stimulated fingertip control. Aerobic exercise may have affected the cardio-pulmonary functions of the elderly in a desirable direction, although they were not measured in the present study. These speculations may be overly optimistic, since psychological factors such as an increase in self confidence might also explain the present results to some extent, especially in light of the obvious improvements in 6-minute walk distance observed even among those with low participation rates.

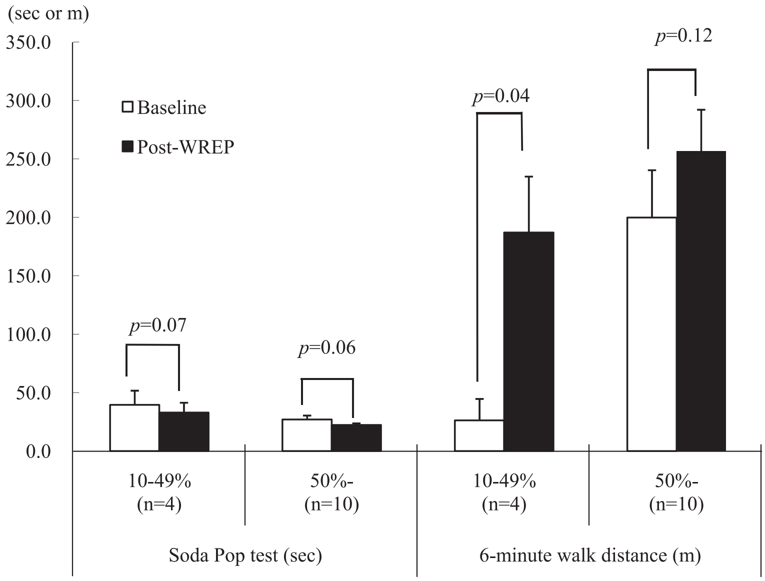

Fig. 1 Changes in performance of Soda Pop test and 6-minute walk distance according to participation rates.
Vertical lines represent standard errors of the mean. The p-values are derived from paired t-tests. Subjects who had participated in 50% or more classes showed significantly longer 6-minute walk distance at baseline than low-rate participants (p=0.002, independent t-test). There were no significant differences in the performance of the Soda Pop test at baseline according to participation rates (p=0.36).

On the other hand, we observed no improvements in balance. While this program included tasks that could be performed sitting in a chair, balance can typically be characterized as an ability to stand on two legs, and is an absolute prerequisite in prevention of falls. Future research should consider employing balance training on two legs while devising means to secure the participant's safety.[17] Neither did we find an improvement in posture change ADL, which tests the ability to stand up from a sitting or lying position. The reason for this is probably due to the fact that we could not adequately train trunk muscles in the present program. To adopt these exercises, there would be a number of problems that would require solutions in advance, such as the number of staff to support the participants, sufficient time, and a way to secure safety of the elderly during such exercises. Moreover, these issues have to be addressed since they are closely related to cost-effectiveness and risk management of the interventions as well as their efficacy.[7,18]

We found no significant improvements in handgrip force, sit and reach, stork stand, or catching a ruler. As mentioned above, no change in the stork stand was to be expected since we could not train the participants for balance. However, these tests, may not have been reliable or sensitive enough to detect subtle changes in the performances of these tests among older adults.[19]

It is rather well known that aerobic exercise is related to a lowering of blood pressure.[20] In the present study, combined exercises, including resistance trainings were related to a reduction in both diastolic and systolic blood pressure. It was reported that resistance exercise increases blood flow in the upper limbs, which would subsequently lead to increased vascular extensibility resulting in a decrease in blood pressure.[21] We have also observed a significant increase in the level of blood total cholesterol, a finding we did not anticipate. Although there is a possibility of pre-analytic sources of variation,[22,23] that finding is considered to be due to an improvement in nutritional status rather than deterioration caused by increased thermogenesis.[24] In addition, blood analyses were not carried out right after the class but about a one-year interval, which implies the possibility of longer-term change of the participants that may be attributable not only to the exercise but other factors such as diet change. Future research should, in fact, address this issue, and appropriately assess any changes in the dietary habits of the participants since it is an especially important factor in administering a tailored exercise program to the frail elderly.[25,26] On the other hand, higher total cholesterol is reportedly associated with a lower incidence of stroke.[27] Combined exercise might have the potential of preventing cardiovascular disease as well as improving physical function and ADL.

In this study, by CES-D, we observed no significant change in the proportion of subjects with depression even though physical activity has been associated with an improvement in depressive moods.[28] This may be due to the very small number of our subjects who fell into the depressive category, resulting in insufficient statistical power. The test of cognitive function[29] should also be included in any future study of the frail elderly since it is also related to depression.[30]

In the present analysis, we found that even those subjects with low participation rates showed improved performance in the 6-minute walk and Soda Pop tests. It was also found that high-rate subjects already had significantly longer 6-minute walk distances at baseline than did the low-rate participants, which suggests that the participation rates might reflect the fitness level of the participants. Thus, even a slight increase in activity had the potential to elicit greater improvement in the lower-rate group, *i.e.* the low fitness group at baseline. It could also be argued that for high-rate group that was already better-off at baseline, the amount or intensity of the classes provided was insufficient for them to show additional improvement. It is also possible that participants exposed to even a low level of exercise may be able on their own to develop exercise habits, although we did not gather information on any out-of-class activity of participants in the present study. Incidentally, the reason for the low participation rates was thought to be the insufficient number of personnel available to help participants get to the location, or their involvement in other competing activities of the facility such as bathing. We consider it important in future to manage these aspects of the program more appropriately as well as the content of the program itself.

It has been recognized that strengthening muscles is an important factor in maintaining the functional independence of older adults.[31] It has also been reported that an exercise program that combined balance and resistance training was effective in preventing falls.[7] Indeed, in 2007, the American College of Sports Medicine specifically recommended that it is especially important for older adults to take part in resistance training.[18] Furthermore, it has been recommended to prescribe individualized exercise plans according to the participant's level of fitness or disability and to arrange the place and time of the exercise so that the elderly may enjoy ready access to repetitive exercise. Approaches such as providing transportation to the exercise location are also important in motivating the individual to continue to exercise. We designed the program with exercises that can be performed with just elastic bands, dumbbells, or self-weights in an attempt to make the exercises readily accepted and easy to perform continuously.

It is especially important to minimize the risk of accident or injury when performing exercises among older adults. Moreover, no standardized method has yet been determined. All the exercises we prescribed could be performed in a sitting position, and the exertion of the exercises was restricted to 50% of the maximal oxygen uptake. Furthermore, we were careful to gradually increase the strength of the exercises.

In a previous study by Harada *et al.*, significant improvements in lower limb muscular strength or flexibility, as well as increased physical activity were reported in their controlled study of community-dwelling elderly aged 65 to 74.[9] That study involved 60-minute, twice-weekly, exercise sessions over three months. In the present study, we lengthened the duration of the classes compared to that in previous studies, aiming at longer lasting effects and habituation to exercise.[13] We tried to evaluate the effect of the exercise classes at the midpoint. The tests in which we found significant differences at the end of the program, *i.e.* Soda Pop test and 6-minute walk distance, had already improved by the interim and the differences between the interim results and those at 6 months were not significant (data not shown). In this study, we did not follow the participants further to see how long the beneficial effects would last. Nor did we have control groups with different class durations to evaluate whether the effects of exercise might differ according to those durations. Since the aspect of interventions that help participants to establish lasting exercise habits are recognized as important for the persistence of the effect,[32] we believe that certain benefits accrued from the six-months class.[33] Further studies with longer follow-ups and control groups of different intervention durations are needed to resolve these unanswered questions. To accomplish the aforementioned well-designed larger-scale clinical trials, researchers should make further efforts toward collaboration.

Several limitations of the present study need to be addressed. First, the present study did not employ a control group. Although we observed significant improvements in several tests and ADL domains, the effect of such classes should be assessed by an intervention study with an appropriately assigned control group. Moreover, the outcome of such interventions should be evaluated by a third group that is blinded to the intervention assignment. Second, the number of subjects was small. Further study, possibly involving multiple facilities and enrolling more participants, should be designed. In the present analysis, we found a significant difference only in the Soda Pop test and 6-minute walk distance. It is possible that some tests we employed in this study may not be reliable for evaluating the elderly.[19] Furthermore, our highest priority was to ensure the safety of the exercises. Training that strengthens the muscles of the trunk, back, and abdomen, or improves balance should be included to examine their effects.

In conclusion, a 6-month WREP for the institutionalized elderly was effective in improving ADL of the mobility and hand manipulation domains as well as the Soda Pop test and 6-minute walk distance, which were considered to correspond to the domains of improved ADL.

ACKNOWLEDGEMENTS

The authors wish to express their sincere appreciation to the participants, and to the personnel of the social welfare facilities involved. We are especially grateful to Ms. Kuniko Takihi and Ms. Tomoko Kameyama for their valuable assistance.

REFERENCES

1) Statistics and Information Department Minister's Secretariat Ministry of Health Labor and Welfare, Japan. Vital Statistics of Japan, 2006. 2008, Kosei Tokei Kyokai, Tokyo.
2) Fukuda Y, Nakao H, Yahata Y, Imai H. In-depth descriptive analysis of trends in prevalence of long-term care in Japan. *Geriatr Gerontol Int*, 2008; 8: 166–171.
3) Karlsson M, Mayhew L, Rickayzen B. Long term care financing in four OECD countries: Fiscal burden and distributive effects. *Health Policy*, 2007; 80: 107–134.
4) Tsutsui T, Muramatsu N. Japan's universal long-term care system reform of 2005: containing costs and realizing a vision. *J Am Geriatr Soc*, 2007; 55: 1458–1463.
5) Ishikawa M, Tamakoshi K, Yatsuya H, Suma K, Wada K, Otsuka R, Matsushita K, Zhang H, Murata C, Kondo T, Toyoshima H. Factors related to frequency of engaging in outside activities among elderly persons living an independent life at home. *Nagoya J Med Sci*, 2006; 68: 121–130.
6) Suetta C, Aagaard P, Magnusson SP, Andersen LL, Sipila S, Rosted A, Jakobsen AK, Duus B, Kjaer M. Muscle size, neuromuscular activation, and rapid force characteristics in elderly men and women: effects of unilateral long-term disuse due to hip-osteoarthritis. *J Appl Physiol*, 2007; 102: 942–948.
7) Skelton DA, Beyer N. Exercise and injury prevention in older people. *Scand J Med Sci Sports*, 2003; 13: 77–85.
8) Takeshima N, Rogers ME, Islam MM, Yamauchi T, Watanabe E, Okada A. Effect of concurrent aerobic and resistance circuit exercise training on fitness in older adults. *Eur J Appl Physiol*, 2004; 93: 173–182.
9) Harada N, Sakakibara H. A trial of community-based well-rounded training for women inhabitants aged 65–74. *Nippon Koshu Eisei Zasshi*, 2007; 54: 15–24. (in Japanese)
10) Ferketich AK, Kirby TE, Alway SE. Cardiovascular and muscular adaptations to combined endurance and strength training in elderly women. *Acta Physiol Scand*, 1998; 164: 259–267.
11) Cao ZB, Maeda A, Shima N, Kurata H, Nishizono H. The effect of a 12-week combined exercise intervention program on physical performance and gait kinematics in community-dwelling elderly women. *J Physiol Anthropol*, 2007; 26: 325–332.
12) Yamauchi T, Islam MM, Koizumi D, Rogers ME, Rogers NL, Takeshima N. Effect of home-based well-rounded exercise in community-dwelling older adults. *J Sports Sci Med*, 2005; 4: 563–571.
13) Asai H, Shinkai S, Ido E. Effectiveness of exercise training for a short period on QOL for the elderly living in a home for the aged. *Jpn J Phys Edu, Health Sport Sci*, 2001; 46: 269–279.
14) Nishigaki T, Koshimizu E, Aoki A, Toji H, Suei K, Iwasaki H. The relationship between physical fitness and activities of daily living in older adults. *Hum Perform Meas*, 2005; 2: 1–9.
15) Edermann BE, Murray SR, Mayer JM, Sagendorf K. Influence of cup stacking on hand-eye coordination and reaction time of second-grade students. *Percept Mot Skills*, 2004; 98: 409–411.
16) Radloff LS. The CES-D Scale: A self-report depression scale for research in the general population. *Appl Psych Meas*, 1977; 1: 385–401.
17) Islam MM, Nasu E, Rogers ME, Koizumi D, Rogers NL, Takeshima N. Effects of combined sensory and muscular training on balance in Japanese older adults. *Prev Med*, 2004; 39: 1148–1155.
18) Nelson ME, Rejeski WJ, Blair SN, Duncan PW, Judge JO, King AC, Macera CA, Castaneda-Sceppa C. Physical activity and public health in older adults: recommendation from the American College of Sports Medicine and the American Heart Association. *Med Sci Sports Exerc*, 2007; 39: 1435–1445.
19) Coldham F, Lewis J, Lee H. The reliability of one vs. three grip trials in symptomatic and asymptomatic

subjects. *J Hand Ther*, 2006; 19: 318–326.
20) Pescatello LS. Exercise and hypertension: recent advances in exercise prescription. *Curr Hypertens Rep*, 2005; 7: 281–286.
21) Collier SR. Sex differences in the effects of aerobic and anaerobic exercise on blood pressure and arterial stiffness. *Gend Med*, 2008; 5: 115–123.
22) Tolonen H, Ferrario M, Kuulasmaa K. Standardization of total cholesterol measurement in population surveys--pre-analytic sources of variation and their effect on the prevalence of hypercholesterolaemia. *Eur J Cardiovasc Prev Rehabil*, 2005; 12: 257–267.
23) Ockene IS, Chiriboga DE, Stanek EJ, 3rd, Harmatz MG, Nicolosi R, Saperia G, Well AD, Freedson P, Merriam PA, Reed G, Ma Y, Matthews CE, Hebert JR. Seasonal variation in serum cholesterol levels: treatment implications and possible mechanisms. *Arch Intern Med*, 2004; 164: 863–870.
24) Miller MD, Crotty M, Whitehead C, Bannerman E, Daniels LA. Nutritional supplementation and resistance training in nutritionally at risk older adults following lower limb fracture: a randomized controlled trial. *Clin Rehabil*, 2006; 20: 311–323.
25) Fiatarone MA, O'Neill EF, Ryan ND, Clements KM, Solares GR, Nelson ME, Roberts SB, Kehayias JJ, Lipsitz LA, Evans WJ. Exercise training and nutritional supplementation for physical frailty in very elderly people. *N Engl J Med*, 1994; 330: 1769–1775.
26) Sullivan DH, Roberson PK, Smith ES, Price JA, Bopp MM. Effects of muscle strength training and megestrol acetate on strength, muscle mass, and function in frail older people. *J Am Geriatr Soc*, 2007; 55: 20–28.
27) Iso H, Jacobs DR, Jr., Wentworth D, Neaton JD, Cohen JD. Serum cholesterol levels and six-year mortality from stroke in 350,977 men screened for the multiple risk factor intervention trial. *N Engl J Med*, 1989; 320: 904–910.
28) Brown AK, Liu-Ambrose T, Tate R, Lord S. The effect of group-based exercise on cognitive performance and mood in seniors residing in intermediate care and self-care retirement facilities: a randomized controlled trial. *Br J Sports Med*, 2008; 43: 608–614.
29) Koch HJ, Gurtler K, Szecsey A. Correlation of MMSE, SKT and clock test scores in patients with mild and moderate dementia. *Nagoya J Med Sci*, 2005; 67: 93–99.
30) Dotson VM, Resnick SM, Zonderman AB. Differential association of concurrent, baseline, and average depressive symptoms with cognitive decline in older adults. *Am J Geriatr Psychiatry*, 2008; 16: 318–330.
31) Lee MJ, Kilbreath SL, Singh MF, Zeman B, Lord SR, Raymond J, Davis GM. Comparison of effect of aerobic cycle training and progressive resistance training on walking ability after stroke: a randomized sham exercise-controlled study. *J Am Geriatr Soc*, 2008; 56: 976–985.
32) Langhammer B, Lindmark B, Stanghelle JK. Stroke patients and long-term training: is it worthwhile? A randomized comparison of two different training strategies after rehabilitation. *Clin Rehabil*, 2007; 21: 495–510.
33) Campbell AJ, Robertson MC, Gardner MM, Norton RN, Tilyard MW, Buchner DM. Randomised controlled trial of a general practice programme of home based exercise to prevent falls in elderly women. *BMJ*, 1997; 315: 1065–1069.