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Original Study

Community-Based Exercise Program is Cost-Effective by Preventing Care and Disability in Japanese Frail Older Adults

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Keywords:
Care prevention program
long term care insurance
older adults
Japanese

A B S T R A C T

Background: In Japan, older adults are assessed by frailty checklist for care prevention. However, the effect of care prevention programs in community-dwelling frail older adults is still unclear.
Objectives: The purpose of this study was to investigate whether the care prevention program would reduce care and disability and to measure its cost-effectiveness in frail older adults.
Design: This is a prospective study using propensity score matching.
Setting and subjects: A total of 610 community-dwelling older adults were recruited in 2 cities of Japan.
Intervention: Subjects in the exercise group (n = 305) attended physical exercise sessions once a week for 16 consecutive weeks. The exercise sessions were in a standardized format consisting of moderate-intensity aerobic exercise, progressive strength training, flexibility and balance exercises, and cool-down activities. The control group (n = 305) received only screening evaluation.
Measurements: Primary outcome was long term care insurance requirement certification during the 1-year follow-up period. Secondary outcome measurements were changes of frailty checklist, and care and medical cost.
Results: Twenty-five subjects (8.1%) in the exercise group and 55 (18%) in the control group were newly certified for long-term care insurance service requirement in 1 year after the intervention (RR = 2.16, 95% CI = 1.46–3.20). Consequently, the health care cost for the subjects in the exercise group was significantly lower than in the control group ($P < .001$). Moreover, subjects in the exercise group had significant improvements in total scores of the frailty checklist compared with the control group that worsened after 1 year (exercise group: from 7.41 ± 3.98 to 7.11 ± 4.00, control group: from 7.34 ± 4.27 to 8.02 ± 4.81, F = 12.84, $P < .001$).
Conclusion: These results suggested that physical exercise is effective in preventing the progression of frailty and further disability in older adults living in the community. We could save heath care costs by our care prevention program.
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The aged population in Japan is increasing faster than in any other country. Frailty in older adults is a serious problem in aged countries, such as in Japan. In general, frailty can be defined as a vulnerable state that places older adults at high risk for adverse health outcomes, such as falls, hospitalization, and mortality.[1] Therefore, to prevent the adverse outcomes of frailty, multicomponent exercise programs have been implemented and provided a beneficial effect on activities of daily living (ADLs) and instrumental ADL disability for community-dwelling moderately frail older adults.[2]

Japan implemented a long term care insurance (LTCI) system in April 2000 to deal with the extremely rapid aging process of our population. Before 2000, long term care services were provided under a tax-based social welfare system targeting seniors with limited economic resources and family support.[3] After LTCI implementation, however, LTCI services have been provided to the elderly who are certified, as a support requirement or care requirement according to their care needs and certification assessment.[4] The selection process for classifying dependent older adults is first based on a questionnaire that evaluates a person's current mental and physical condition (74 items), and then the first decision is reached by computerized algorithm. The second decision is made by a long term care approval board based on the first computer decision, doctor's recommendation, and the home-visit report. Finally, people who are certified as dependent older adults are subdivided into 7 levels (requiring support levels 1 and 2 and care levels 1 to 5) depending on their conditions. They are provided home- and community-based or institutional services according to the care needs. Individuals who are not eligible for long term care or support care may use preventive care services.

The authors declare no conflicts of interest.

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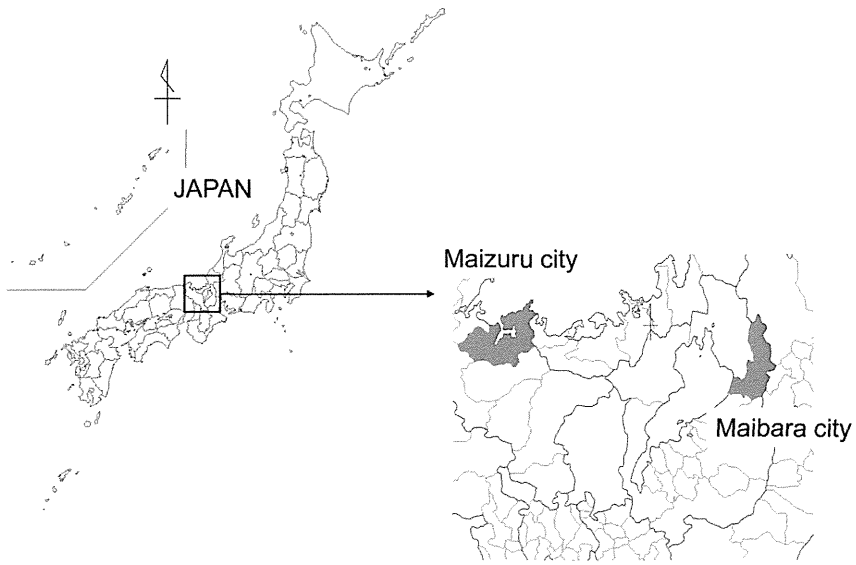

Fig. 1. Location of Maibara and Maizuru City in Japan.

In 2006, the LTCI system was revised and new preventive benefits were introduced. The aim of this system was to allocate the limited resources to impaired elderly by providing services intended to improve physical strength, nutritional status, oral function, and mental health.[5] The LTCI system also increased emphasis on preventive care services for those with lower needs and those at risk for needing care in the future, in which pre-frail and frail older adults can be selected by a frailty checklist. The local governments provide a frailty checklist to uncertified older adults, and all older adults are required to fill out a basic yes or no questionnaire consisting of assessments of their lifestyle, motor abilities, nutrition, oral function, seclusion, forgetfulness, and emotions. According to the results of impairment on a specific domain, the government provides several intervention programs to prevent care and disability of older adults; however, the effect of the care prevention program on frail older adults is still unclear.

The aim of the current study, therefore, was to evaluate the effect of an exercise intervention on care and disability classified by LTCI service requirement certification and health care cost in community-dwelling older adults. We hypothesized that subjects who attend the care prevention program have a lower chance of being certified for the LTCI service requirement than nonparticipants, and as a result, the intervention can save health care costs.

Methods

Subjects

We analyzed the cohort data from a prospective study: the Japan Multi-center Aging Cohort for Care prevention. In this study, in 2009, we recruited community-dwelling older adults who were

Table 1
Frailty Checklist of Japan

Domain	Question	Items	Yes	No
Lifestyle	1	Do you ride the bus or train alone?	0	1
	2	Do you buy household goods for everyday use?	0	1
	3	Do you withdraw and deposit savings?	0	1
	4	Do you visit your friends' homes?	0	1
	5	Do you give advice to family and friends?	0	1
Motor abilities	6	Can you climb stairs without holding onto a handrail or the wall?	0	1
	7	Can you get up from a chair without grabbing something?	0	1
	8	Are you able to keep walking for about 15 minutes?	0	1
	9	Have you fallen in the past year?	1	0
	10	Are you very worried about falling?	1	0
Nutrition	11	Have you ever lost more than 2–3 kg of weight in a 6-month period?	1	0
	12	BMI is less than 18.5.	1	0
Oral function	13	I cannot eat hard foods as well as 6 months ago.	1	0
	14	Have you ever choked on tea or soups?	1	0
	15	Are you concerned with being thirsty?	1	0
Seclusion	16	Do you leave your home at least once a week?	0	1
	17	Compared to last year, has the number of times you go out decreased?	1	0
Forgetfulness	18	Are you told that you are forgetful or you always tell me the same thing?	1	0
	19	Do you look up phone numbers and make phone calls yourself?	0	1
	20	Do you sometimes forget the date and month?	1	0
Emotions	21	(In the past 2 weeks) I do not feel fulfillment in my daily life.	1	0
	22	(In the past 2 weeks) The activities I used to enjoy are no longer enjoyable.	1	0
	23	(In the past 2 weeks) The activities I used to carry out with ease have become troublesome.	1	0
	24	(In the past 2 weeks) I do not think I am a useful person.	1	0
	25	(In the past 2 weeks) I feel tired for no reason.	1	0

BMI, body mass index.

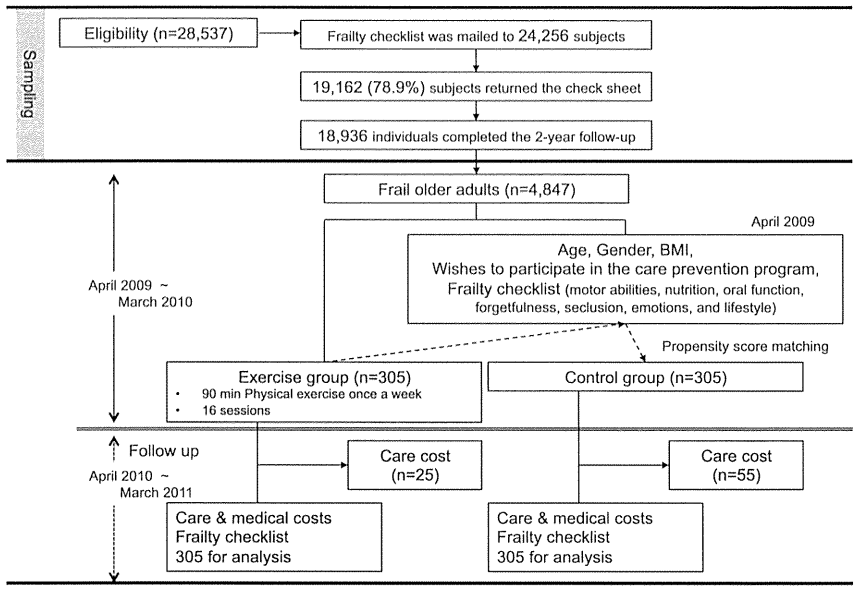

Fig. 2. A flow chart showing the distribution of subjects throughout the trial.

independent in ADLs in 2 cities (Maibara City in Shiga Prefecture and Maizuru City in Kyoto Prefecture) (Figure 1). The exclusion criteria were older adults who were already ADL-dependent and were eligible to receive benefits from LTCI services.

A total of 28,537 residents were eligible for this study in April 2009. The self-administered frailty checklist was mailed to 24,256 subjects, and the response rate was 78.9%. We further excluded individuals who died or moved from the cities in the 2-year follow-up, and analyzed 18,936 elderly. Subjects for the care prevention program were recruited using direct mail. We screened subjects in an initial interview and recruited frail older adults 65 years or older.

This study was conducted in accordance with the guidelines proposed by the Declaration of Helsinki, and the study protocol was reviewed and approved by the Ethics Committee of Kyoto University Graduate School of Medicine.

Frailty Checklist

The frailty checklist includes simple yes/no questions concerning lifestyle (questions 1 to 5), motor abilities (questions 6 to 10), nutrition (questions 11 to 12), oral functions (questions 13 to 15), seclusion (questions 16 to 17), forgetfulness (questions 18 to 20), and emotions (questions 21 to 25) (Table 1). We calculated the scores in each of these 7 domains.

Table 2
Baseline Characteristics of the Study Subjects in Exercise and Control Groups

	Exercise Group (n = 305)		Control Group (n = 305)		*P* Value
	Mean	SD	Mean	SD	
Age, y	79.7	6.3	80.3	6.6	.275
Gender, female	231 (75.4%)		238 (78.0%)		.560*
Height	151.5	8.0	151.1	8.3	.509
Weight	53.1	10.0	51.8	10.2	.128
BMI, kg/m^2	23.0	3.4	22.6	3.5	.129
Falls in past year	107 (35.1%)		114 (37.4%)		.670*
Total scores of frailty checklist	7.41	3.98	7.34	4.27	.814

BMI, body mass index.
*Chi-square test.

Impaired physical condition was defined as having 3 points or more in motor ability items according to the Japanese Ministry of Health, Labor, and Welfare. Malnutrition was defined as having 2 points in nutrition items, poor oral health as having 1 point or more in oral function items, seclusion as having 1 point or more in seclusion items, cognitive decline as having 1 point or more in forgetfulness items, and depressive mood as having 2 points or more in emotion items. Frailty was defined by scores of 10 or more points on questions 1 to 20.

Definition of Frail Older Adults in this Study

In this study, we defined frail older adults as those who need to maintain or to improve daily functions. These individuals are not eligible for the LTCI service requirement as defined by the government, but have a high risk of becoming dependent based on the results of the frailty checklist.[5] Those older adults are defined as having impaired motor abilities, malnutrition, poor oral health, or impaired lifestyle as described in the previous paragraph.

Care Prevention Program

The subjects received 90 minutes of group training sessions once a week for 16 consecutive weeks. The exercise class was supervised by a physiotherapist. The exercise sessions were conducted according

Table 3
Comparison of New LTCI Service Requirement Certification Between the 2 Groups

	Exercise Group, n (%)	Control Group, n (%)	RR	95% CI
LTCI requirement	25 (8.1%)	55 (18.0%)	2.16	1.46–3.20
Support level				
1	11	15		
2	7	14		
Care level				
1	4	13		
2	3	7		
3	0	3		
4	0	3		
5	0	0		

CI, confidence interval; LTCI, long term care insurance; RR, relative risk.

Table 4
Frailty Checklist Scores in Each Group at Baseline and After Intervention

	Baseline		After Intervention		Group × Time Interaction	
	n (%)	*P* Value	n (%)	*P* Value	F Value	*P* Value
Motor ability domain score						
Exercise (n = 305)	181 (59.5)	.414	177 (58.0)	.087		
Control (n = 305)	185 (60.7)		158 (51.7)			
Nutrition domain score						
Exercise (n = 305)	10 (3.4)	.348	11 (3.5)	.364		
Control (n = 305)	13 (4.3)		8 (2.6)			
Oral function domain score						
Exercise (n = 305)	114 (37.5)	.210	113 (37.0)	.073		
Control (n = 305)	104 (34.0)		94 (30.7)			
Forgetfulness domain score						
Exercise (n = 305)	139 (45.6)	.430	120 (39.3)	.037		
Control (n = 305)	142 (46.7)		145 (47.6)			
Seclusion domain score						
Exercise (n = 305)	66 (21.6)	.349	19 (6.2)	<.001		
Control (n = 305)	61 (20.0)		50 (16.5)			
Emotions domain score						
Exercise (n = 305)	144 (47.3)	.407	133 (43.6)	.008		
Control (n = 305)	140 (46.0)		167 (54.7)			
Lifestyle domain score						
Exercise (n = 305)	47 (15.5)	.517	36 (11.7)	.003		
Control (n = 305)	46 (15.1)		64 (21.0)			
Total score						
Exercise (n = 305)	7.41 ± 3.98		7.11 ± 4.00		12.84	<.001*
Control (n = 305)	7.34 ± 4.27		8.02 ± 4.81			

*Two-way analysis of variance adjusted for age and gender.

to a standardized format consisting of 20 minutes of moderate-intensity aerobic exercise, 30 minutes of progressive strength training, 20 minutes of flexibility and balance exercises, and 20 minutes of cool-down activities. The aerobic exercise was composed of global movement of the legs, trunk, and arms involving all joints and major muscle groups in activities such as dance. Strength training consisted of progressive resistive exercises using an elastic band. A sequence of progressively difficult exercises was also performed to improve static and dynamic balance. The control group received screening evaluation only.

Propensity Score Matching

We used propensity score matching to assemble a cohort of the exercise group, then the 2 groups would be well matched on all measured baseline characteristics, such as age, gender, body mass index, wishes to participate in the care prevention program, motor abilities, nutrition, oral function, forgetfulness, seclusion, and emotions. We estimated the scores of the exercise group for each subject using a multivariable logistic regression model. We were able to match 305 pairs of exercise and control subjects who had similar propensity scores.

Outcome Measures

Primary outcome was the new LTCI service requirement certification at 1 year after the conclusion of the intervention. Secondary outcomes were changes of frailty checklist, LTCI cost, and medical cost. The LTCI cost indicates use of home care services, nursing care, or day care services and nursing home. The utilization records of LTCI benefit services during 1 year were collected from the local governmental office. The medical cost covers almost all medical treatment, including diagnostic tests, medications, surgery, supplies and materials, physicians, and other personal cost.

Statistical Analysis

Baseline characteristics of the intervention and control groups were examined for comparability of the 2 groups. Differences in the demographic variables between the 2 groups were analyzed using the Student *t* test or chi-square test. Relative risk was then calculated, and the chi-square test was used to evaluate the effect of the care prevention program on the new LTCI service requirement and the influence on each domain of frailty checklist. Analysis of covariance was used to determine the effect of the care prevention program on total points of frailty checklist, using age as covariates. Post hoc Tukey tests were used to assess whether group or time periods showed significant differences. Multiple logistic regressions using a stepwise method was performed to investigate which of age, gender, or the decline in frailty checklist for each category was independently associated with the change of frailty checklist (improvement, maintenance, or deterioration). Finally, differences in the care and medical cost between the 2 groups were analyzed using the Student *t* test. Data were entered and analyzed using the Predictive Analytics Software (Windows version 18.0, SPSS, Inc., Chicago, IL). A *P* value less than .05 was considered statistically significant for all analyses.

Table 5
Change of Each Domain in Frailty Checklist After Exercise Intervention

Dependent Variables	Adjusted Odds Ratio (95% Confidence Interval)						
	Motor Abilities	Nutrition	Oral Functions	Forgetfulness	Seclusion	Emotions	Lifestyle
Change in checklist	2.29 (1.58–3.31)	5.32 (1.52–18.62)	—	1.77 (1.22–2.57)	—	—	—

1 = improvement, 0 = maintenance or deterioration.

Table 6
Comparison of Long Term Care Insurance and Medical Costs Between the 2 Groups

	Exercise Group, n = 305	Control Group, n = 305	*P* Value
	Mean ± SD	Mean ± SD	
Care costs* dollars	1126.8 ± 1797.9	4430.7 ± 6324.7	<.001
Medical costs dollars	2458.7 ± 1968.7	3458.0 ± 5847.1	<.001

One dollar = 88 yen.
*Exercise group: n = 25, control group: n = 55.

Results

Of the 610 individuals, all subjects completed the 1-year follow-up: 305 in the exercise group, and the others in the control group (Figure 2). All 16 scheduled intervention sessions were completed. The median relative adherence was 100% (25th–75th percentile, 88%–100%) in the exercise group. No fall incidents or health problems, such as cardiovascular or musculoskeletal complications, occurred during training sessions or testing. Minor problems were muscle ache and fatigue. All problems were managed easily using adjustment of the intervention, and they improved during the intervention. Subjects in the exercise and control groups were comparable and well matched with regard to their baseline characteristics (Table 2).

During 1 year after the intervention, 25 subjects (8.1%) in the exercise group and 55 (18.0%) in the control group were newly certified for the LTCI service requirement. Therefore, the relative risk for new LTCI service requirement in the control group compared with the exercise group was 2.16 (95% confidence interval [CI] = 1.46–3.20) (Table 3).

At baseline, all domains of the frailty checklist were not significantly different between the 2 groups (Table 3). Subjects in the exercise group had significant improvements in total scores of the frailty checklist compared with the control group that worsened after 1 year (exercise group: from 7.41 ± 3.98 to 7.11 ± 4.00, control group: from 7.34 ± 4.27 to 8.02 ± 4.81, F = 12.84, $P < .001$) (Table 4) as well as in forgetfulness, seclusion, emotion, and daily life domains ($P < .05$); however, the other domains were not significantly different between them ($P > 0.05$).

Stepwise logistic regression analysis revealed that motor ability domain (OR = 2.29, 95% CI 1.58–3.31), nutrition domain (OR = 5.32, 95% CI 1.52–18.62), and forgetfulness domain (OR = 1.77, 95% CI 1.22–2.57) were significant and independent determinants of the change in frailty checklist ($P < .001$) (Table 5).

Finally, we calculated the cost-effectiveness of this intervention, and found that subjects in the exercise group spent significantly lower care cost than the control group (exercise group: $1126.8 ± 1797.9, control group: $4430.7 ± 6324.7, $P < .001$) (Table 5), whereas subjects in the exercise group spent significantly less on medical costs than the control group (exercise group: $2458.7 ± 1968.7, control group: $3458.0 ± 5847.1, $P < .001$) (Table 6).

Discussion

In this study, we addressed the role of the physical exercise program for frail older adults, and have shown that the subjects who received physical exercise sessions demonstrated a lower incidence of new LTCI service requirement, improved frailty checklist, and reduced care and medical costs.

The current results indicated that the care prevention program had a beneficial effect on frailty in older adults. Specifically, the physical exercise program showed more beneficial effects on older adults with impaired motor ability, malnutrition, and forgetfulness. Previous studies also confirmed the benefits of physical exercise training on frail older adults.[6,7] In addition, a systematic review by Daniels and colleagues[2] suggested that multicomponent exercise programs have a positive effect on ADL and instrumental ADL disability for community-living moderate physically frail older adults. These reports and our findings suggested that the physical exercise program is effective in preventing frailty.

Moreover, our results indicated that the care prevention program could reduce health care costs. Owing to the positive effect on cognition, seclusion, depression, and instrumental ADLs, the program might also be associated with fewer medical costs. In addition, intervention by the prevention program showed a lower incidence of new LTCI service requirement certification, resulting in lower care costs. On the other hand, Frick and colleagues[8] reported that the physical exercise program was not cost-effective by evaluating the cost-effectiveness of fall-prevention programs for fall-related hip fractures in older adults. These results suggest that all the physical exercise programs are not always cost-effective. Further study is required to determine how to perform cost-effective interventions in frail older adults.

There were several limitations of this study that warrant mention. First, we did not measure physical performance, and used only the frailty checklist to define frailty. There is a possibility that the frailty checklist may not be the best instrument to define frailty, such as the Short Physical Performance Battery that evaluates balance, gait, strength, and endurance by examining an individual's ability.[9] Second, our study design was not a randomized controlled trial. Therefore, these findings should be interpreted with caution.

This is the first study to demonstrate that the care prevention program is effective to improve the scores of the frailty checklist. In addition, subjects who received the care prevention program demonstrated a lower incidence of new certification of LTCI service requirement with a lower cost during the follow-up period. These results implicated the importance of care prevention programs to reduce care and disabilities in older adults. A larger study is needed to confirm the present results and to evaluate the most effective exercises for the prevention of disability in older adults.

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Original article

Urban-rural differences in physical performance and health status among older Japanese community-dwelling women

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ABSTRACT

Background/Purpose: Assessment of physical performance allows the identification of health and functional independence among older adults. Several factors, such as environmental conditions, influence the results; therefore our objective was to compare the physical performance and the health status between older Japanese women living in urban and rural communities.

Methods: The Japanese women were aged ≥65 years, and recruited in urban ($n = 41$, age = 73.8 ± 3.92 years) and rural ($n = 54$, age = 73.8 ± 4.15 years) locations through the local press. Physical performance was assessed by the Timed Up and Go (TUG), one leg stand (OLS), repeated chair stands (CS) and handgrip strength (HGS) tests. Health status was investigated using socio-demographic characteristics; anthropometric measures and body composition; physical activity, a pedometer, Life-Space Assessment (LSA); Geriatric Depression Scale; incidence of falls, fear of falling; and medical information. Variables were compared by χ^2 test, Independent-Samples t test and Mann Whitney U-test.

Results: Rural individuals presented a better performance in the HGS test ($p = 0.01$) than urban individuals, who had a better performance in the CS test ($p < 0.001$). No statistical differences were found in the TUG or OLS tests. Rural women also had a higher body mass index ($p = 0.04$), waist circumference ($p < 0.01$), and body fat percentage ($p = 0.014$) than urban women, who showed higher scores in LSA ($p < 0.001$). Concerning medical information, more rural women complained of low back pain ($p = 0.01$) and gastrointestinal problems ($p = 0.02$).

Conclusion: Our findings showed that the physical performance and health status varied according to the place. Rural individuals had worse results in the CS test, but a better performance in the HGS test than urban individuals. We emphasize that health interventions should address the specific demand of each location.

1. Introduction

Japan has the world's highest average life expectancy, reaching 86.4 years for women, according to the 2010 records.[1] However, specialists have defended that the process of aging "well", such as remaining healthy, vigorous, and free of disability, is as important as the absolute number of years achieved.[2]

One of the enemies to the process of aging well is a sedentary lifestyle; a key risk of premature morbidity and mortality. Following this concept, the assessment of physical performance is receiving special attention, because it allows an early identification of older adults at risk of health and functional decline, situations that typically precede the onset of disability.[3,4] Moreover, physical performance measures are predictors of functional, psychological, and social health,[4,5] and additionally, in this complex relationship, they are influenced by several factors, such as environmental conditions.

Studies have shown that physical activity levels differ according to the environment; in rural communities, the physical activity level could be expected to be lower than that in urban neighborhoods.[6,7] A study conducted in Japan examined the association between the neighborhood environment and physical activity among Japanese adults[8]; however, to our knowledge, no study has directly compared the physical performance and the health status

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between older urban and rural community-dwelling adults yet. Therefore, we aimed to compare the physical performance and the health status between older Japanese women living in urban and rural communities.

2. Methods

2.1. Study participants

The participants were older Japanese women, recruited in urban ($n = 41$) and rural ($n = 54$) locations through the local press, by requesting healthy, community-dwelling volunteers to collaborate in this research. The inclusion criteria were age ≥65 years and the ability to perform the physical tests, to fill the questionnaires, and to give consent to participation in the study. Data was collected from November 2011 to March 2012.

Rural and urban locations were defined and classified directly with emphasis on the morphology of their settlements and the wider geographic context of such settlements. This approach ensured that the focus remained clearly on the most physical aspects of these environments, as described elsewhere.[9] The participants in an urban location lived in Kyoto city (1.47 million people), while the population in rural environments was <9000, in an area of 15.2 km^2. For this categorization, we also considered factors beyond the population size, such as differentiation by economic field, in which rural residents used the land as a direct source of income or wealth generation.

2.2. Physical performance

In the Timed Up and Go (TUG) test, participants were asked to stand up from a standard chair, walk 3 meters, turn, and sit down again; a shorter measured time indicated better ability. In the one leg stand (OLS) test, participants were instructed to stand unassisted on one leg, eyes opened and arms by the side of the trunk; the OLS was timed not exceeding 30 seconds, with a longer time indicating better balance ability. In the repeated chair stands (CS), participants were asked to stand up and sit down five times from a chair as quickly as possible, keeping their arms folded across the chest. Finally, the handgrip strength (HGS) was tested with a standard handheld dynamometer (HHD) (mTas F-1; ANIMA, Tokyo, Japan). The participant was asked to stand up and hold the dynamometer with arms parallel to the body; the HGS was measured for both hands once on each side, and the higher value was used to characterize the maximum muscle strength of the participant, as previously described.[10] HGS was expressed in kg.

2.3. Health status

Socio-demographic characteristics, such as age, living structure, educational level and current work; anthropometric measures, such as body mass index (BMI), waist circumference (WC); and body composition features, such as body fat percentage (BF%), skeletal muscle mass index (SMMI), arm muscle mass, and leg muscle mass—collected by bioelectrical impedance analysis (Inbody 430; Biospace Co, Ltd, Seoul, Korea)—were obtained.

Regarding the bioelectrical impedance, the instrument makes use of eight tactile electrodes: two are in contact with the palm and thumb of each hand and two with the anterior and posterior aspects of the sole of each foot. The individual stands with their soles in contact with the foot electrodes and grabs the hand electrodes. Resistance of arms, trunk, and legs was measured at frequencies of 5, 50 and 250 kHz. Examination provided values for skeletal muscle mass, BF% and segmental muscle mass (right and left arms and legs, and trunk). From these measurements, skeletal muscle mass was then adjusted by height and for segmental muscle mass. This bioelectrical impedance method had previously been validated as having a strong correlation to muscle volume and fat mass, as measured by dual energy X-ray absorptiometry.[11]

Moreover, regular practice of physical activity (PA) was collected by a self-administered questionnaire and was characterized by moderate walking, gymnastics, resistance training, yoga, golf, and other activities. Then, pedometer data (Yamax Powerwalker EX-510; Yamasa Co., Ltd., Tokyo, Japan), and Life-Space Assessment (LSA)[12] were also collected. Concerning the pedometer, the participants were recommended to wear the instrument in the morning and to register the number of steps in a diary at the end of the day. After 1 week, they were requested to send the pedometers by mail to researchers, including the diary record. The diary record was then matched with the pedometer memory and an average of steps counting in 1 week was used in analysis.

For psychological characteristics, the Geriatric Depression Scale (GDS-15) was used. Finally, information about the incidence of falls in a 1 year period, fear of falling, medical information, such as medical consultation frequency and hospitalization history in the last 6 months, medications, and comorbidities were also collected. Through a self-administered questionnaire, individuals were asked about the presence or absence of low back pain, diabetes, osteoporosis, hypertension, hyperlipidemia, arthropathy and gastrointestinal problems; their report was considered positive when they were assumed to be using prescribed medication for the specific comorbidity.

The study protocol was approved by the Kyoto University Graduate School of Medicine Ethics Committee (No. E1245, 2011). All participants were informed of the purpose and procedures of the study and a written consent was obtained.

2.4. Statistical analysis

Aiming to verify the normality of the data, the Shapiro-Wilk test was used. Participants' characteristics were investigated using a descriptive analysis. Socio-demographic and categorical health-status variables were compared by living environment, using the χ^2 test, while continuous variables were analyzed by the Independent-Samples t test, if normally distributed, or the Mann Whitney U-test, if skewed. Concerning the functional performance tests, only the CS was analyzed by the Independent-Samples t test, while for the others, the Mann Whitney U-test was used. The considered level of significance was $p < 0.05$. For data analysis, the Statistical Package for the Social Science (SPSS, IBM Inc., Chicago, IL, USA), version 15.0 was used.

3. Results

In total, 95 older women (urban $n = 41$, age 73.7 ± 3.92 years; rural $n = 54$, age 73.7 ± 4.15 years) participated in this study. Socio-demographic characteristics are shown in Table 1. Despite no statistical differences in their characteristics, an environmental difference was observed. Those in rural areas lived in groups of three persons or more (52.8%), while those in urban environments had the same proportion in all categories of living alone, living with a spouse, or three persons or more (33%). Moreover, rural participants showed a slightly lower educational level, in which most of them studied until junior high school (40%), while urban women studied until high school (34.3%) or university (20%). Additionally, rural women did not work (45.1%) or were engaged in farm work (37.3%), and the majority of urban women were retired (67.5%).

As shown in Table 2, participants living in rural neighborhoods presented a better performance in HGS ($p = 0.01$) than urban participants. In contrast, urban participants had a better

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Table 1
Socio-demographic characteristics of older women living in urban and rural communities.

Variable	Urban	n	Rural	n	p
Age (y)[a]	73.7 ± 3.92	41	73.7 ± 4.15	54	0.99
Living structure[b]					
Alone	33.3	39	15.1	53	0.07
With spouse	33.3		32.1		
With 3 persons or more	33.3		52.8		
Education[b]					
Elementary school	11.4	35	6	50	0.17
Junior high school	20		40		
High school	34.3		26		
Technical school	14.3		20		
University	20		8		
Work[b]					
Does not work	67.5	40	45.1	51	0.23
Integral period	2.5		3.9		
Part-time work	2.5		2		
Autonomous work	2.5		2		
Farm work	12.5		37.3		
Volunteer work	7.5		7.8		
Other	5		2		

[a] Mean ± SD.
[b] Percentage.

performance in CS ($p < 0.001$). No statistical differences were found in TUG or OLS.

According to anthropometric measures, rural women had a higher BMI ($p = 0.04$), WC ($p < 0.01$) and BF% ($p = 0.01$) than urban women. A tendency to more engagement in physical activity ($p = 0.05$) and higher scores in LSA ($p < 0.001$) was found in urban participants, even though a statistically insignificant higher average pedometer count was found in rural participants.

The median found in the GDS was low (urban = 1 vs. rural = 2); most urban women had ≥ seven medical consultations (30%) in the last 6 months, while rural women had five or six (24.5%); 7.5% of urban versus 5.6% of rural participants were hospitalized in the last 6 months; and 80% of urban and 81.5% of rural participants took medications. With regards to the above mentioned factors, no statistical differences were found between the two groups, however more rural women complained of low back pain (rural = 27.8% vs. urban = 7.3%, $p = 0.01$) and gastrointestinal problems (rural = 16.7% vs. urban = 2.4%, $p = 0.02$) (Table 3).

4. Discussion

The main findings of our study were that physical performance and health status differed according to the environment; women from rural areas had a better performance in HGS and a worse performance in CS. Additionally, rural women presented higher BMI, WC, BF%, a higher prevalence of low back pain, and gastrointestinal problems, and higher weekly average step counts than urban women. By contrast, those living in urban areas showed higher regular physical activity engagement and higher scores in LSA.

Table 2
Physical performance measurements of older women living in urban and rural communities.

Variable	Urban	n	Rural	n	p
Timed Up and Go (s)[a]	6.44 (5.9–7.35)	41	6.59 (6–7.55)	54	0.44
One Leg Stand (s)[a]	23.35 (10–30)	41	28.31 (12.3–30)	54	0.38
Handgrip Strength (kg)[a]	22 (19–26)	40	25 (21.7–26.5)	54	0.01
Five Chair Standing (s)[b]	7.43 ± 1.75	41	8.97 ± 2.18	54	<0.001

[a] Median (interquartile).
[b] Mean ± SD.

Table 3
Health status measurements of older women living in urban and rural communities.

Variable	Urban	n	Rural	n	p
BMI (kg/m^2)[a]	21.9 ± 2.50	41	23.2 ± 3.45	54	0.04
Waist Circumference (cm)[a]	72.2 ± 5.78	39	76.7 ± 8.14	54	<0.01
Body Fat Percentage[a]	29.0 ± 6.49	39	32.5 ± 6.67	54	0.01
SMMI (kg/m^2)[b]	8.28 (7.63–8.6)	39	8.01 (7.67–8.63)	54	0.91
Arm muscle mass (kg/m^2)[b]	1.36 (1.2–1.51)	39	1.42 (1.33–1.61)	54	0.06
Leg muscle mass (kg/m^2)[b]	4.59 (4.29–4.98)	39	4.41 (4.1–4.71)	54	0.08
Pedometer[b]	5791 (3992–7634)	35	6734 (5447–7794)	53	0.07
Physical activity[c]					
No	17.9	39	35.4	48	0.05
Almost everyday	20.5		6.3		
2 or 3 per week	46.2		52.1		
1 or 2 per month	15.4		6.3		
Life-space assessment[a]	97.0 ± 17.7	32	73.2 ± 19.9	53	<0.001
Geriatric Depression Scale[b]	1 (0–3)	33	2 (0.75–4)	54	0.19
Fear of falling[c]	45.7	35	40.7	54	0.64
Fell in past year[c]	35.1	37	24.1	54	0.25
Medical consultation[c]					
No	17.5	40	18.9	53	0.36
1∼2 times	27.5		20.8		
3∼4 times	15		17		
5∼6 times	10		24.5		
7 or more	30		18.9		
Hospitalization[c]	7.5	40	5.6	54	0.70
Medications[c]	80	40	81.5	54	0.99
Low back pain[c]	7.3	41	27.8	54	0.01
Diabetes[c]	4.9	41	13	54	0.18
Osteoporosis[c]	24.4	41	25.9	54	0.86
Hypertension[c]	43.9	41	38.9	54	0.62
Hyperlipidemia[c]	26.8	41	35.2	54	0.38
Arthropathy[c]	24.4	41	22.6	54	0.84
Gastrointestinal problems[c]	2.4	41	16.7	54	0.02

SMMI = skeletal muscle mass index.
[a] Mean ± SD.
[b] Median (interquartile).
[c] Percentage.

Even though no statistical difference was found, rural participants had a slightly greater arm muscle mass and urban participants a higher leg muscle mass. One possible explanation for this difference is regarding their lifestyle routine (e.g., rural women were more involved in farm work, which usually requires hand and general strength, while urban women seem to be more engaged in physical activity and had higher scores in LSA). However, this is only a hypothesis, as lifestyle factors were not investigated in detail.

Concerning the CS, rising from a chair is a complex task involving movement of all body segments from head to foot; the activity requires coordinated joint mobility, strength and balance to enable the center of mass to be transferred forward and upward from the seated position to erect standing.[13] One could say that the lower performance in CS in rural participants may be linked with the higher incidence of low back pain, as this comorbidity was identified by Janssen et al (2002) as a subject-related determinant for CS in a review study. Additionally, in our research, the CS was done with arms folded across the chest; studies have verified that standing without using armrests requires different kinematics and kinetics, and older adults usually do trunk flexion to keep the balance. Beginning the movement from a position different from erect is also related with increased time movement[14] and could be influenced by low back pain as well. In our studied rural sample, the farm work might be a possible cause for this comorbidity[15] as a kyphotic or squatting position is frequently required in agriculture.

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Moreover, the class of medications usually prescribed for low back pain includes nonsteroidal antiinflammatory drugs, skeletal muscle relaxants and opioid analgesics; unfortunately, we did not investigate the classes of the medication that the participants used, however, there is evidence supporting the fact that some of this class of medications may be related with their gastrointestinal problems as well.[16]

The values for HGS and CS in urban individuals were similar to previous studies developed in urban communities in Japan[10,17]; however, our studied rural group had higher HGS and lower CS in comparison.

A study aimed at identifying HGS cutoffs for women and its results showed the threshold of 21 kg at any level of BMI, with values below the cutoff indicating mobility limitations.[18] Another study verified that poor HGS is a predictor of accelerated dependency in activities of daily living (ADL) and cognitive decline in the oldest old[5] and predicts cause-specific mortality in middle-aged and elderly individuals.[19]

Additionally, individuals from rural environments had higher BMI, WC and BF% than those from the urban cohort, however, both groups are inside the cutoff values for BMI, according to the World Health Organization (normal range = 18.5–24.99 kg/m^2)[20] and specific WC (80 cm) for the diagnosis of metabolic syndrome in Japanese women.[21] Such differences on anthropometric features are also linked with lifestyle factors, however, as we did not investigate dietary habits, we cannot extend our conclusions to this point.

TUG has been used as a screening of fall risk.[22] The values we found were better in comparison with other studies; Herman et al (2011) verified a mean score of 9.5 ± 1.7 seconds, ranging from 5.4 to 15.6 seconds, however, their study involved both genders. Another study developed in Japan, with only women (mean age = 78.6 years), found a mean score of 10.3 seconds for TUG,[23] and a review study referenced an Australian research that found a mean score of 8.5 ± 1.6 seconds for women aged 70–79 years.[24]

Another review study conducted by Michikawa et al (2009) identified reference values for OLS time in elderly participants, and stated that this measure of balance can be used as a practical marker to screen the elderly for frailty. Because various procedures are used, the measured values varied widely from study to study, with a mean of 6.9 to 32.9 seconds reported for women aged 70–79 years (considering the maximum time of 60 seconds). Clearly, this variation may be due to individual, as well as procedural, differences. Also, many studies provided combined data for men and women. In their original research, the authors found a median value of 27.8 seconds for women aged 75–79 years, also considering the maximum time of 60 seconds execution.[25] Despite the different methodology, our results are similar to theirs.

In our study, rural women showed lower scores in LSA and a tendency to be less engaged in physical activity. Our results were consistent with another urban–rural comparison study conducted in the United States, which showed that rural older women had a higher BMI and less engagement in physical activity than their urban counterparts.[7] Consistently, another study showed that rural participants had less engagement in physical activity and less active transportation.[6] In Japan, a study was conducted to examine the association between the neighborhood environment and physical activity among Japanese adults; it was reported that people living in neighborhoods with a high residential density, good access to shops, the presence of sidewalks, and the presence of bike lanes, had higher physical activity levels.[8] Furthermore, Peel et al (2005), in a study about the measure of mobility for older community-dwelling adults, found that rural participants also had lower physical performance and function, but higher scores in LSA than urban participants. The authors justified their findings, stating that rural individuals usually travel farther to accomplish tasks, and some community services enabling residents to stay at home, may be unavailable in rural communities.[26]

A study conducted by Van Dyck et al (2010) showed additional evidence regarding pedometer data, in which they concluded that rural individuals took fewer average steps per day than urban ones, contrasting with our results, which showed a higher weekly average step count in individuals from a rural environment; however, their sample was younger (mean age = 42.4 years) than ours.[6] A national survey conducted in Japan showed 5823 steps per day, on average, in people aged 65–74 years, similar to our findings from an urban community, but lower than those observed in the rural community.[27] We may explain our results by the socio-demographic data, that participants from the rural community were more engaged in work and farm activities, even though no statistical differences were found. When performing these daily activities, it is expected that they will take more steps per day. Additionally, we may reinforce the results of LSA supposing that, if participants from rural communities had lower scores, they do not travel farther and use less transportation than urban ones. Aiming to move through the community or going to work, they may do it on foot. Consequently, they accumulated more steps per day/week. Moreover, they may walk to nearby fields for agriculture work.

LSA is an important measure of frailty, as it allows early verification of mobility restriction, which may permit the identification of persons in the course of disability development and at a time when such disability can be prevented. This approach in community dwelling older adults showed strong correlations with age,[28] physical performance measures,[12] daily activities,[12,28] comorbid conditions,[12,28] depressive symptoms,[12] social activities,[28] self-reported health,[12,28] and poor psychological well-being.[28]

Our findings should be useful in targeting and evaluating interventions that enable people to maintain independent mobility and physical performance in their living environment. We emphasize that health interventions should address the specific demand of each location.

To our knowledge, no study has been done to show a direct comparison regarding physical performance and general health status in older urban and rural Japanese women, and our study is the first that shows some evidence about these variables. However, it has several limitations, such as the small sample size, a different number of respondents in each assessment, and it includes only one gender. Therefore, further studies with a variability of geographic settings and a larger sample are needed to continue the investigation concerning differences in the environment to confirm our findings.

Disclosure statement

None of the authors have conflicts of interest or financial disclosures.

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COMMISSION REPORT

Toward the realization of a better aged society: Messages from gerontology and geriatrics

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1. Background: Recent medical advancements, and improvements in hygiene and food supply have led to Japan having the longest life expectancy in the world. Over the past 50 years, the percentage of the elderly population has increased fourfold from 5.7% in 1960 to 23.1% in 2010. This change has occurred at the fastest rate in the world. Compared with France, where the percentage of the elderly population has increased just twofold in the past 100 years, Japanese society is aging at an unprecedented rate. In addition, the percentage of the very elderly (aged 75 years and over), comprising more frail people, exceeded 10% of the nation's population in 2008. In such a situation, many elderly Japanese wish to spend their later years healthy, and wish to achieve great accomplishments in their lives. To achieve that, rather than considering an aging population as a negative social phenomenon, we should create a society where elderly people can enjoy a healthy, prosperous life through social participation and contribution.

Factors that hamper the elderly from leading a healthy life include various psychological and social problems occurring in older age, as well as a high incidence of diseases. Therefore, gerontology, which focuses on health promotion of the elderly by encompassing the study of social welfare, psychology, environment and social systems; and geriatrics, which focuses on health care of elderly people and carried out research, education and practices to promote health in the elderly, are becoming more important. Furthermore, along with a need for multidisciplinary care to support geriatric medicine, the development of a comprehensive education system for aged-care professionals is awaited. Thus, we should now recognize the importance of gerontology and geriatrics, and a reform of medical-care services should be made in order to cope with the coming aged society.

Population aging is a global phenomenon. The actions being taken by Japan, the world's most aged society, have been closely watched by the rest of the world. Japan's aged society has been posing not only medical, nursing and welfare problems, but also complex problems closely associated with economy, industry and culture. Therefore, to solve these

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problems, a macroscopic integration and cooperation among industries, education institutions, administration and community through an interdisciplinary approach including medical science, nursing science, nursing care, study of social welfare, social science, engineering, psychology, economics, religion and ethics should be made. Regarding the promotion of gerontology, the "**Committee for Establishing a Scientific Community for Sustainable Aged Society**" of the Science Council of Japan also prepared a proposal and this was announced on 20 April 2011.

2. Current situation and problems

(1) Promotion of social participation and contribution of elderly people

In Japan, the overall labor force rate is expected to decrease in the near future as a result of the low birth rate and high life expectancy. In contrast, many elderly people, particularly the young-old, have sufficient physical strength to fulfil their job duties and make a social contribution. For these people, a social structure where elderly people can work should be developed through re-educating the elderly and providing various job types. Promotion of social participation and contribution of the elderly is expected to cause a substantial increase in the labor force. Furthermore, it is also expected to contribute to not only the upturn of national economic activity through an increase in total consumption, but also a decrease in the number of elderly people who are likely to be in need of care. Therefore, in order for elderly people to be engaged in various social activities, strategies for developing a social structure for re-education, various employment statuses and employment opportunities should be prepared. However, as the total number of jobs is fixed, consideration should also be given to young workers.

(2) Fostering medical specialists for aging

Older people often suffer from many diseases, together with geriatric syndromes with multiple etiologies. Signs and symptoms vary according to each individual, and are often atypical; therefore, the patients visit different hospitals and receive many screening tests and prescriptions at the same time. To solve this problem, an effective screening system carried out by a primary-care doctor, and privacy-preserving medical data sharing among hospitals and clinics are needed. In a geriatric clinical setting, health-care professionals should be aware of the physical traits of older people who often develop not only dementia, but also geriatric syndromes, such as depression, falls and urinary incontinence, so that a holistic approach with consideration of nursing care is required. However, the existing Japanese medical education system is not prepared for medical professionals enabled to respond to the aforementioned requirements. Thus, the fostering of medical professionals who can provide comprehensive care – especially for the oldest-old – such as geriatric specialists and medical professionals who understand the principles of elderly care, is urgently needed.

(3) Diagnosis of elderly-specific diseases and reform of medical-care services

In Japan, the diagnostic system for elderly-specific diseases, including dementia, and reform of medical care services are markedly delayed. The current status concerning diagnosis, care and nursing should be investigated to collect academic data. In order to accumulate evidence for providing safe elderly care and nursing, the promotion of clinical research and a marked expansion of geriatric medical centers with high-level medical services are eagerly awaited.

(4) Promotion of home-based care and multidisciplinary care

To reduce the length of stay in acute hospitals, to reduce the physical burden of health-care professionals working at acute hospitals and to meet the demand of older people who prefer to remain in their own homes, further promotion of home-based care is needed. In addition, "multidisciplinary care" is increasingly needed to meet various demands in the medical care and welfare of the elderly. It is considered important to share countermeasures against the problems of disease prevention, medicine, care and welfare among health-care professionals in medicine, care and welfare, and cooperate by making the best use of health-care professionals' specialties.

3. Contents of the proposal

The subcommittee for aging, thus, provided the following proposal:

1 Development and promotion of systems that enable elderly people to participate socially and make a contribution using an interdisciplinary approach among the various areas,

including nursing science, nursing care, study of social welfare, social science, psychology, economics, religion and ethics, as well as medical sciences;
2 Promotion of gerontology, reform and enhancement of geriatrics in undergraduate, postgraduate and lifelong education;
3 Building geriatric medical centers in each area, and accumulating large-scale evidence of geriatric diseases and geriatrics; and
4 Structural development and promotion of home-based care and multidisciplinary care.
Through implementation of the above measures, Japan is expected to function as a successful example for the rest of the world. **Geriatr Gerontol Int 2012; 12: 16–22.**

Keywords: education, elderly, geriatrics, gerontology, multidisciplinary approach.

1. Preface

Over the past 50 years, the percentage of elderly people in the population of Japan has increased fourfold from 5.7% in 1960 to 23.1% in 2010. Japanese society is aging at an unprecedented rate. According to the National Institute of Population and Social Security Research, the percentage the elderly population is estimated to continue increasing, reaching 26.0% in 2015 and further increasing rapidly. After 2020, the percentage of elderly people in the population is expected to stabilize; however, as a result of a decrease in the total population, the percentage will further increase to 40.5%, peaking in 2055. Japan will face a super-aged society, in which 40% of the population will be over 65 years-of-age. Unless appropriate countermeasures are taken, such as a rapid improvement in clinical skills and knowledge among physicians involved in geriatrics, marked advances in the prevention of lifestyle-related diseases, prevention of geriatric syndromes including dementia, and marked expansion of home-based care or local-care, we cannot avoid a situation where many frail elderly people have to live with no support. However, many issues remain; that is, a marked reduction of long-term care facilities, a reduction in length of hospital stay in acute hospitals and a delay in expanding home-based care system, and whether thanatology reflects a social change. We should also consider social issues, such as ageism, caregiver burnout, dignified death and the appropriateness of placing gastrostomy tubes in elderly patients with dementia. To provide dignified care, particularly for older people, appropriate care should be carried out in not only the terminal phase, but also during the last few years before death.

However, despite the challenge, little is known about gerontology and geriatrics in Japan, and they are not fully used in clinical settings or education. To solve this problem, a macroscopic integration and cooperation are needed, using an interdisciplinary approach involving medical science, nursing science, nursing care, study of social welfare, social science, engineering, jurisprudence, economics, psychology and ethics. Furthermore, along with the reform and enhancement of geriatrics in undergraduate and postgraduate education, fostering specialists who can practice geriatrics is needed. Also, for non-geriatricians or general practitioners who currently and prospectively provide care in clinical settings, an educational system should be prepared to deepen their understanding of geriatric medicine.

2. Current situation and measures

(1) Social contribution of the elderly and the medical economy

As a result of the low birth rate, the percentage of the total labor force (aged 20–64 years) is expected to decrease in Japan. Elderly people are usually divided into two groups based on age: 65–84 years (young-old) and 75 years and older (old-old). Although many elderly people, particularly the young-old, have sufficient physical strength to fulfil their job duties and a make social contribution though productive activity, they are not fully utilized. The promotion of social participation and the contribution of the elderly is expected to contribute to creating purpose in their lives, as well as an increase of a substantive productive population, financial stability and self-sustainability for the elderly, and an upturn of national economic activity through an increase of total consumption. Therefore, for elderly people to be engaged in various social activities, strategies for developing a social structure for re-education, volunteer activity, various employment statuses and employment opportunities should be prepared using an interdisciplinary approach involving study of social welfare, social science and economics. However, as the total number of jobs is fixed, consideration should also be given to young workers.

Life expectancy in Japan is the highest in the world. Japan also has the highest healthy life expectancy. In 2008, USA health expenditures accounted for 16% of the nation's gross domestic product (GDP), twice the Japanese rate. Compared with other countries, Japanese health expenditures as a percentage of GDP accounted for two-thirds of that of France and Germany, suggesting that we have the most cost-effective health-care

systems. In addition, the annual cost of health care has been approximately 670 000 yen per elderly person for the past 10 years. However, the aging of the population is expected to impact on future spending growth. Sasaki compared life-long medical costs between the longevity and non-longevity groups, and found that longevity decreases medical costs and has positive economic impacts.[1] Thus, it is important to enhance preventive medicine to achieve longevity, make continuous efforts for cost-effective medicine and improve satisfaction with the health-care systems. Discussion of geriatric medicine should be made after disclosing the aforementioned facts to the public.

Problems in geriatric medicine are closely linked to social structures, including care, welfare and dwelling surrounding the health-care system. To reveal and solve problems regarding the elderly and an aged society, the promotion of gerontology using an interdisciplinary approach is increasingly needed.

Regarding employment opportunities for older workers and future directions of medicine, care and welfare, discussion should be made among specialists from various health-care specialties. The Japan Geriatrics Society and the Japan Gerontological Society, as a core organization, should expand their activities to achieve a "society where elderly people can enjoy their lives" with the cooperation of the National Center for Geriatrics and Gerontology, Tokyo Metropolitan Geriatric Hospital and Institute of Gerontology, the Institute of Gerontology the University of Tokyo, and J. F. Oberlin University.

(2) The current state of geriatric medicine and its direction

Geriatric disorders have several features.

First, diseases occur as a result of a decline in organ systems associated with aging. Therefore, even if a disease is not so severe, a patient might have been developing an unexpectedly marked decline in organ systems. In addition, homeostatic function with aging, biophylaxis capacity and nutritional absorption capacity often decrease, and symptoms become chronic and refractory.

In terms of clinical symptomatology, older people often complicate many diseases together with a geriatric syndrome with multiple etiologies. Signs and symptoms vary according to each individual, and are often atypical. Response to drugs is different in elderly compared with non-elderly people.

Older people are more likely to develop multiple diseases, and visit different hospitals and receive many screening tests and prescriptions at the same time;[2] thus, total expenditures on the elderly become inevitably high, which has been said to cause financial collapse of the Japanese health insurance system. However, regarding this issue, we should focus on the medical cost required for a single disease between elderly and non-elderly people, and we should be aware that restricting the increasing financial burden on patients to receive screenings or prescriptions for each disease would be ageism for elderly people and uncontroversial. However, unnecessary duplication of the screening given at each hospital should be avoided. To achieve this, an effective screening system carried out by primary-care physicians, and privacy-preserving medical data sharing of test results and medication among hospitals and clinics are needed. Regarding medications, the Japan Geriatrics Society has prepared the "Guidelines for medical treatment and its safety in the elderly" as an outcome of the sponsored research in Japan Foundation on Aging and Health.[3] The guideline explained standard medical treatments mainly for the elderly by giving examples of low priority, such as making an easy prescription or non-evidence-based prescription to prevent deterioration of chronic disease. In either retrospective fee-for-service or a prospective payment system (fixed amount), physicians should provide the same level of prescription to each patient. To carry out effective screening for the elderly or evidence-based medical treatment, a constructive research system should be developed separately from health-care reform in terms of medical economy. The Japanese government has decided to abolish the existing medical insurance system for those aged 75 years and older; however, the following principles stated in the existing medical insurance system should be included in the next system for the elderly: (i) elderly disease prevention; (ii) comprehensive geriatric assessment; and (iii) incentives to promote discharge planning.

Older people often develop functional disorders associated with chronic disease or aging. Functional disorders not only jeopardize the independence of people and pose social disadvantage, but also lead to secondary disease. This often makes elderly people fully dependent, resulting in lower quality of life. Therefore, in the treatment of geriatric disorders, priority should be given to functional outcomes, as well as life expectancy and the prognosis of organ systems. In addition, because a psychological change associated with an environmental change often leads to a deterioration of symptoms in elderly people, treatment policy and discharge planning should be prepared with a holistic consideration of the patient using the comprehensive geriatric assessment (CGA). In geriatric medicine, it is important not only to protect organ systems, but also to maintain physical function to prevent assisted living.

To maintain independent living, a person needs to have sustained function, including daily life functions, cognitive function, emotion and sociality (family, friends, job). CGA is used to determine the aforementioned functional status both comprehensively and systematically. The results of CGA give us a clue of what kind of

support can help maintain independent living or assisted living with minimum care for elderly people. However, CGA is not a popular tool. Therefore, we should examine ways of increasing the awareness of CGA to promote its use for the improvement of geriatric medicine.

End-of-life care for elderly patients is an extremely important issue in geriatric medicine; however, very few elderly people in Japan have made advance directives to show their wishes about their health care during the end-of-life period. In geriatrics, there are so many issues to discuss, including confirmation of patient's wishes, the need of a health-care representative, and the relationship between the patient and their physician. Therefore, we should investigate the awareness of end-of-life care for elderly patients among health-care professionals, including physicians and nurses, people involved in care, patients, and their families, to discuss future direction of care. Regarding end-of-life care in elderly people, "Attitudes toward end-of-life care in elderly patients",[4] which was announced in 2000 by the ethics committee of the Japan Geriatrics Society and is currently under revision, and a proposal prepared by the end-of-life care research group,[5] should be referred.

(3) Fostering health-care professionals involved in geriatric medicine

Despite the growth of the elderly population, physicians with special geriatric training are not expected to increase under the present system of medical education. In order to solve the problem of care for the growing elderly population, the educational system should be restructured to provide an understanding of geriatric medicine for non-geriatricians, general practitioners and physicians working at care facilities that provide care for elderly patients. This might be an effective and practical approach for fostering physicians taking care of the elderly. To provide sufficient geriatric knowledge to general practitioners and non-geriatricians, the education program should include basic geriatrics contents to retain quality of geriatric care, which would be required even for non-geriatricians. The Japan Geriatrics Society has published *Clinical Handbook for Active Aging and Geriatric Care* for physicians, which aims to provide basic knowledge of elderly-specific symptoms, assessment, treatment and care. It is expected that using this handbook for students, residents, practitioners and non-geriatricians might contribute to the expansion of geriatric medicine. In the USA, in order to deal with a shortage of geriatric specialists, medical students are required to receive a minimum geriatrics education.[6]

(4) Promotion of geriatric disease clinical research

In Japan, a system for making diagnosis and providing treatment and care for patients with elderly diseases, including dementia, has not been fully developed. In elderly care, it is important to make an accurate diagnosis and collect clinical evidence to reflect diagnosis and evidence in clinical settings. To accumulate evidence of geriatric medicine and nursing, the promotion of clinical research and a marked expansion of geriatric medical centers with high-level medical services are eagerly awaited.

Currently, there are just two geriatric medical centers in Tokyo and Nagoya. Therefore, the number of centers should be increased and should be placed in each district (Hokkaido, Tohoku, Hokuriku, Kanto, Koshinetsu, Tokai, Kinki, Chugoku, Shikoku and Kyushu). The National Center for Geriatrics and Gerontology, as a core facility, is required to examine the efficacy of geriatrics-related activities and consistency with countermeasures, supervise multicenter studies and clinical research projects, and strive to enhance geriatric medicine through the standardization of geriatric medicine and care, and preparation of medical guidelines. In this process, each center, as a platform of geriatric medicine, should accumulate clinical data, and is also required to function as a facility to educate non-geriatricians.

The Japan Geriatrics Society has been carrying out clinical research on the treatment of hyperlipemia involving the elderly aged 75 years and over. An establishment of a support system for such clinical research and an accumulation of evidence on the efficacy of nutrition and exercise are also considered important.

(5) Promotion of home-based care and multidisciplinary care

Based on the demand of older people who prefer to remain at home, and a government policy that aims to shorten the length of hospital stay and the number of beds to decrease the growing burden of health-care expenditure, the promotion of home-based care has been provided. However, the medical structure of home-based care has not been fully devised, requiring further development of a medical and nursing structure where older people can receive continuing treatment and care, including rehabilitation, within the local community, while not being too dependent on the hospital stay, or not being forced to choose home-based care. Enhancement of home-based care might contribute to reducing the burden on physicians and nurses at acute hospitals, and might also compensate for other care services, such as emergency care and obstetrics.

One of the concerns of home-based care among physicians, patients and their families is the difficulty with hospital admissions in the event of sudden illness or deterioration. To solve this problem, the National Center for Geriatrics and Gerontology has established a "Home-based care unit". Preregistration from both a general practitioner and the patient is necessary for

admission to this unit, with the intention to continue home-based care. The patient can be admitted any time by referral of a general practitioner. The outcome of this program is eagerly awaited.

In home-based care settings, a group of professionals from diverse disciplines mutually cooperate to provide care for a patient. For such a multidisciplinary approach, it is important to choose appropriate professionals according to the condition and disease stage of the elderly patient. However, this multidisciplinary approach involves some problems. One is the legislative "gap" between health-care providers registered under the Medical and Dental Practitioners Acts and the Act on Public Health Nurses, Midwives and Nurses, and nursing care providers registered under the Long-Term Care Insurance. The other is the discrepancy in the principle between health-care and nursing-care providers. To solve these problems, it is essential to examine them along with the legislative issues, and promote home-based care, particularly at universities offering courses in geriatrics and local community hospitals where there are accumulating results of a multidisciplinary approach to caring for elderly patients, to further promote the cooperation between medical-care and social-welfare services.

3. Proposals

We make the following proposals as countermeasures against various issues in geriatrics:

(1) Development and promotion of a system that enables elderly people to participate socially and make a contribution using an interdisciplinary approach among the various areas, including nursing science, nursing care, study of social welfare, social science, engineering, psychology, economics, religion and ethics, as well as medical sciences.

Promotion of social participation and contribution of the elderly, while considering the total number of jobs and young workers, is expected to contribute to creating purpose in their lives, and reduce the growing number of older people who become frail or in need of care. It is also expected to bring about an increase in a substantial productive population, financial stability and self-sustainability for the elderly, and an upturn of the national economic activity through an increase of total consumption.

(2) Promotion of gerontology, reform, and enhancement of gerontology and geriatrics in undergraduate, postgraduate and lifelong education.

To solve problems associated with elderly people or an aged society, gerontological and geriatric research and education should be enhanced. By fostering medical professionals who understand the physical and mental traits of older adults, and those who can provide a holistic approach with consideration to organic integration with nursing care, provision of reliable care and nursing services is expected.

(3) Build geriatric medical centers in each area, and accumulate large-scale evidence of geriatric diseases and geriatrics.

For system reform of diagnosis, treatment and nursing care, evidence should be accumulated through large-scale clinical studies.

(4) Structural development and promotion of home-based care and multidisciplinary medicine and care.

Promotion of home-based care and multidisciplinary medicine and care, particularly at universities offering courses in gerontology and local community hospitals where there are accumulating results of a multidisciplinary approach to care for elderly patients, can be expected to help reduce the burden of physicians and nurses, and meet the demand of older people.

Through implementation of the aforementioned measures, Japan is expected to function as a successful model for the rest of the world.

4. Summary

The phenomenon of an aging population is often considered within a negative spectrum; however, elderly people in need of care only account for 13% of the total elderly population, and this is not being expected to further increase. We should rather focus on the fact of an increasing number of "healthy elderly individuals with rich experience and knowledge", which would not become a negative factor in the future. The restructuring of these healthy elderly resources for social development is believed to bring a permanent bright future, and it is expected that medical-care and social-welfare services will make a significant contribution within this framework. The realization of healthy longevity in society is possible; however, we should be aware that it is only possible by the integration of geriatric medicine and social welfare.

To cope with the problems that come with a rapidly aging society as the world-leading model, the development of elderly-friendly medical devices and nursing-care equipment to avoid a labor shortage is considered essential. Taking the lead in the development of medical equipment for elderly people enables us to provide other countries with aging populations with a model for success, and is also expected to contribute to the creation of new employment and an increase in export as one of the main industrial products in Japan.

The task given to the country with the longest healthy life expectancy is to try to achieve the highest level of elderly satisfaction. As a result of a community change, "roles" and "presence with respect" of the elderly have become weakened, and a medical- and nursing-care "burden" for the younger population has been casting

a dark shadow over the society. As the baby boomer generation ages into elderly status, new roles, including a future health-care workforce and volunteer activities, and community satisfaction should be rebuilt. Gerontology and geriatrics ought to take the lead in showing a practical approach to the industry and the administration to create new images of the elderly.

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Disclosure statement

The authors declare no conflict of interest.

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NUTRITIONAL SUPPLEMENTATION DURING RESISTANCE TRAINING IMPROVED SKELETAL MUSCLE MASS IN COMMUNITY-DWELLING FRAIL OLDER ADULTS

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Abstract: *Objective:* Sarcopenia, the age-related loss of skeletal muscle mass, is highly prevalent in older adults. The aim of this study was to investigate the effects of the combination of resistance training and multinutrients supplementation (including vitamin D and protein) on muscle mass and physical performance in frail older adults. *Methods:* This trial was conducted in Japanese frail older adults (n=77), which underwent a standardized protocol of a 3-month physical exercise intervention. The sample population was divided into two groups, according to the adoption (S/Ex: n = 38) or not (Ex: n = 39) of the additional multinutrient supplementation. The outcome measures of interest for the present analyses were the skeletal muscle mass index (SMI) and several physical performance tests. *Results:* Participants in S/Ex group had significant improvements for the outcome measures, including SMI and maximum walking time ($P<0.05$), compared to those in Ex group. The prevalence of sarcopenia decreased from 65.7% to 42.9% in S/Ex group, while that in Ex group remained unchanged (68.6% to 68.6%) (relative risk = 1.60, 95% CI: 1.03-2.49). *Conclusion:* The results of this study suggest that the combination of resistance training and multinutritional supplementation may be more effective at improving muscle mass and walking speed than an intervention only based on resistance training.

Key words: Sarcopenia, vitamin D, protein, resistance training, muscle mass, older adults.

Introduction

Sarcopenia, the age-related loss of skeletal muscle mass, is highly prevalent in older adults (1). Multiple operational definitions have been proposed for this condition in literature. In the present study, we defined sarcopenia as coexistence of low muscle loss and slow walking speed according to consensus statement released by the Society of Sarcopenia, Cahexia and Wasting Disorders (SSCWD) (2). Sarcopenia is associated with the risk of falls and fractures, physical disability, mobility disorders, and mortality (3-5). The possible causes of sarcopenia are numerous and include increasing age, muscle disuse, endocrine dysfunction, neurodegenerative diseases, and malnutrition (6). In particular, given the strong relationship existing between nutritional status and skeletal muscle, it has been hypothesized that the combination of exercise and nutritional supplementation may be particularly important for adequately targeting sarcopenia (7).

In fact, resistance and/or aerobic exercise are important for the prevention and management of sarcopenia. A recent meta-analysis showed that the resistance training is effective at improving strength (8) and eliciting muscle mass gains in older adults (9). In a previous study, we demonstrated that leg muscle mass and physical performances are improved by a 1-year resistance training protocol in frail older adults (10). In addition, our 6-month pedometer-based walking program showed to effectively increase physical activity, improve physical performance, and augment leg muscle mass in sedentary older adults (11).

On the other hand, nutritional supplementation is similarly important to counteract the detrimental age-related effects on skeletal muscle. In particular, a proper protein intake is important at older age. Dietary protein intake is relevant for the maintenance of muscle mass and strength in community-dwelling older adults (12-13). Protein supplementation has been shown to enhance the muscle strengthening effect of resistance exercise (14-15). Similarly, amino-acids supplementation (crucial for protein synthesis (16)) has shown beneficial effects on muscle mass (17).

Recently, vitamin D has attracted a growing interest of researchers and clinicians in the field of geriatrics. The deficiency of such hormone is quite common in older adults. Several studies suggested that a low 25-hydroxyvitamin D (25(OH) D) concentration is associated with lower muscle strength, reduced physical performance, and increased disability (12, 18-19). Bischoff-Ferrari and colleagues showed that a high daily dose of supplemental vitamin D reduced the risk of falling; however, a low dose of supplemental vitamin D in older adults with vitamin D sufficiency may not reduce the fall risk (20).

The Society for Sarcopenia, Cahexia, and Wasting Disease recently recommended the combination of exercise with protein and/or vitamin D supplementation for reducing the age-related skeletal muscle decline (7). Evidence is still limited with only

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