Regular exercise history as a predictor of exercise in community-dwelling older Japanese people

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Abstract A physically active lifestyle is important across the entire life span. However, little is known about life-long participation in regular exercise among older people. The purpose of the present study was to describe regular exercise throughout a person's lifetime and evaluate the impact of exercise earlier in life on participation in exercise at age 60 and over. The participants were 984 community-dwelling older people aged 60 to 86 years. Each participant's life was divided into five age categories: 12-19, 20-29, 30-39, 40-59, and 60 years and over. The association between exercise at an earlier age and that at 60 years and over was assessed using logistic regression analysis adjusted for potential confounders. Men had exercised throughout their lives more than women. Among women, participation in exercise during their 20s and 30s showed a sharp decline. The preference for exercise differed according to age and gender. Among men, the most common patterns of exercise throughout life were exercise during all the age categories, and starting exercise at age 60 and over; whereas in women the most common pattern was no exercise at all. The adjusted odds ratio of exercise at 40-59 years for exercise at age 60 and over was 5.85 (95% confidence interval: 3.82-8.96) among men and 6.89 (4.23-11.23) among women. Regular exercise in the younger age categories affected exercise at age 60 and over among men, but not among women. Regular exercise at 40-59 years was a strong predictor of exercise at 60 years and over in both men and women.

Keywords : regular exercise, older people, life course, random sampling data

Introduction

Physical activity is an important health behavior across the course of one's life. The benefits of physical activity in preventing health decline and physical function loss have been demonstrated, especially for frail and aged people¹. The Ministry of Education, Culture, Sports, Science and Technology in Japan reported that the participation rate of older people in physical activity and fitness has slightly increased in the past decade^{2,3}. However, more than 40 % of older people aged 70 years and older did not participate in any exercise during the past year⁴. Insufficient physical activity remains a public health concern among older people in Japan.

Engaging in sports activities in childhood and adolescence is known to predict physical activity in adulthood⁵. A low level of physical activity in early life has been found to predict physical inactivity in adulthood⁶. However,

most longitudinal studies have demonstrated that sports activities in early life have an effect on physical activity in young adulthood^{5,6}. It remains unclear whether sports activities in early life are associated with physical activity at an older age. Some studies have found that a history of physical activity was associated with current physical activity in older people^{7,8}. In an earlier study we found that the experience of exercise in adolescence was associated with a higher level of leisure-time physical activity in middle-aged and elderly Japanese women⁹. However, little basic descriptive data exists on individual variation in participation in exercise throughout the life span and the impacts of early exercise on physical activity in later life among community-dwelling Japanese older people.

The purpose of the present study was to describe regular exercise throughout the life course and evaluate the effect of early exercise on the participation in exercise at the age of 60 years and over.

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Methods

Study population. The investigation is a part of the 4th survey of the National Institute for Longevity Sciences - Longitudinal Study of Aging (NILS-LSA), which is a follow-up study on the causes of geriatric diseases and health problems in older people. The NILS-LSA was based on data obtained from interviews and laboratory examinations of medical, nutritional, psychological, and physical fitness variables. The details of the study can be found elsewhere¹⁰. The initial survey of the NILS-LSA involved 2,267 men and women aged 40-79 years, including almost 300 men and 300 women for each decade (40s, 50s, 60s and 70s). The participants were gender- and decade age-stratified random samples of the residents of Obu-shi and Higashiura-cho, Aichi Prefecture, in central Japan. The participants were drawn from resident registrations in cooperation with local governments. All subjects lived or had lived at home in the community. The participants in the present study comprised 523 men and 461 women aged 60-86 years. All the NILS-LSA procedures were already approved by the Ethical Committee of the National Center for Geriatrics and Gerontology, and all of the participants signed a written informed consent.

Measures and Procedures. Regular exercise was assessed using a questionnaire and an interview. The questionnaire was based on a questionnaire developed by the Japanese Lifestyle Monitoring Group¹¹. The participants were asked for the type, time, frequency and duration of their regular exercise from the age of 12 years to the present with the question "What physical activities or sports have you participated in during these age categories?" The participants reported the types of physical activities and sports they had engaged in from a list of alternatives. These were coded as 1) light activities such as walking, gymnastic exercise and gardening, 2) moderate activities such as brisk walking, dancing and swimming for pleasure, 3) vigorous activities with increased breathing and sweating such as jogging and playing tennis, 4) exhausting activities such as various competitive sports. Frequency of participation was defined as how often they participated in physical activities or sports per week. The duration of each activity was calculated with 1 year as the basic unit. Physical activities or sports that were engaged in for at least 20 minutes, once a week and over 1 year, excluding physical education at school, were defined as regular exercise. Life span was divided into five age categories: 12-19, 20-29, 30-39, 40-59 and 60 years and over. The age categories of 40 and over included more years with reference to previous studies^{7,8}, showing physical activity to be stable in middle age¹².

If participants engaged in a number of regular exercises during the same period, the exercise with the longer duration was selected. Interviews were performed by trained staff.

Potential confounders, included age, education, marital

status (never married, married, separated, divorced and be-reaved), annual income (6,500,000 yen or less vs. more than 6,500,000 yen) and chronic conditions including smoking status (never, former and current), self-rated health (excellent, very good, good, fair and poor) and prevalent diseases (hypertension, ischemic heart disease, diabetes, osteoporosis, arthritis and cancer), were investigated using a questionnaire and interview by a physician. Height and weight were measured using a digital scale. Body mass index was calculated by weight divided by height squared (BMI; kg/m²). Body fat mass was assessed by dual X-ray absorptiometry (DXA; QDR-4500A, Hologic, USA). Work-related physical activity was estimated using the same questionnaire developed by the Japanese Lifestyle Monitoring Group¹¹. Work activities were assigned an intensity coefficient of 1.5, 2.5, 4.5 and 7.5 METs (metabolic equivalents) for sedentary work, work done standing or walking, moderately strenuous work and strenuous work, respectively. The work activity scores were calculated by multiplying the intensity coefficients by the total number of minutes spent on the activity over the last 12 months.

Statistical analysis. The statistical significance of the differences in social and health conditions were analyzed by the Cochran-Mantel-Haenszel test for categorical variables and Student's t-test for continuous variables according to participation in regular exercise at age 60 and over. The participation rate in regular exercise was calculated as the percentage of participants who engaged in exercise in each age category. Gender differences in the participation rate in each age category were analyzed using Pearson's chi-squared test. The relationship between regular exercise in the younger age categories and at age 60 and over was evaluated using multiple logistic regression analysis. Both the unadjusted model and the model adjusted for all potential confounders were analyzed. The analyses were performed for men and women separately, as the gender difference in the participation rate in regular exercise was considerable. Statistical testing was performed using the Statistical Analysis System (SAS), release 9.1.3 (SAS Institute Inc. NC, USA). Probability levels of less than 0.05 were considered to be significant.

Results

Table 1 shows the characteristics of the participants by gender according to participation in regular exercise at age 60 and over. The mean age of the study population was 70.0±6.6 years in men and 69.8±6.7 years in women. Age, weight, BMI, annual income, work-related physical activity, smoking, self-rated health, hypertension and arthritis for men; and height, education, work-related physical activity for women were associated with regular exercise at age 60 and over ($p < 0.05$).

The participation rates in regular exercise for age categories 12-19, 20-29, 30-39, 40-59 and 60 years and over

Table 1. Characteristics of the participants according to regular exercise at age 60 and over for men and women

		Men				Women		
		Regular exercise				Regular exercise		
		Yes	No			Yes	No	
		n=342	n=181	<i>p</i> -value		n=263	n=193	<i>p</i> -value
Age	years	70.4 ± 6.3	69.2 ± 7.2	0.048		69.7 ± 6.4	70.2 ± 7.0	0.503
Height	cm	163.6 ± 5.7	162.7 ± 5.9	0.108		150.5 ± 5.6	149.1 ± 6.2	0.010
Weight	kg	62.3 ± 9.0	59.2 ± 8.3	<0.001		51.8 ± 7.7	51.7 ± 8.7	0.829
BMI	kg/m ²	23.3 ± 2.8	22.3 ± 2.8	<0.001		22.9 ± 3.0	23.2 ± 3.4	0.246
Body fat	%	22.9 ± 4.4	22.5 ± 4.6	0.395		32.4 ± 5.1	32.6 ± 5.5	0.688
Education	years	11.9 ± 2.9	11.7 ± 3.0	0.513		11.1 ± 2.3	10.6 ± 2.5	0.033
Marital status	%			0.097				0.295
Never		0.0	2.2			3.1	3.7	
Married		94.4	91.2			71.7	64.0	
Separation		0.6	0.6			0.4	0.0	
Divorce		0.6	0.6			1.9	4.2	
Bereavement		4.5	5.5			23.0	28.0	
Annual income	%							
6,500,000 yen and higher		24.8	35.2	0.013		25.8	29.4	0.401
Work-related physical activity	METs*min*10 ⁻³	130.8 ± 135.9	170.7 ± 151.7	0.002		183.0 ± 85.5	206.8 ± 109.0	0.010
Smoking	%			<0.001				0.910
Never		24.8	20.3			93.9	94.2	
Former		58.1	47.3			2.3	2.6	
Current		17.1	32.4			3.8	3.1	
Self-rated health	%			0.001				0.287
Excellent		6.5	0.6			3.8	5.2	
Very good		33.3	24.7			21.7	15.6	
Good		52.2	63.2			65.0	66.2	
Fair		7.7	9.9			9.1	12.5	
Poor		0.3	0.6			0.4	0.5	
Prevalent diseases	%							
Hypertension		44.5	31.3	0.003		40.7	41.2	0.921
Ischemic heart diseases		6.2	9.3	0.188		7.2	6.8	0.852
Diabetes		11.5	11.0	0.860		7.2	5.2	0.385
Osteoporosis		1.2	3.3	0.093		16.4	17.2	0.827
Arthritis		4.4	11.5	0.002		11.8	17.2	0.102
Cancer		6.2	6.6	0.859		5.7	9.4	0.136

Continuous variables are presented as means ± standard deviation (SD), and categorical variables are presented as percentages. The differences between groups were analyzed by Student's *t*-test for continuous variables and by Cochran-Mantel-Haenszel test for categorical variables. Bold represents significant *p*-value (<0.05). BMI, Body mass index. METs, Metabolic equivalents

are shown Table 2. The percentage of men who had regular exercise was significantly higher than that of women in all of the age categories (*p*<0.05), except for 40-59 years. Among women, a large drop in the percentage reporting participation in exercise was found during the ages of 20-29 and 30-39 years.

The popular type of exercise reported for the different age categories is presented in Tables 3a and 3b. The most popular activities and sports differed both by gender and

by age category. Men frequently reported team sports such as baseball and softball up to 40-59 years of age. In women, volleyball was frequently reported up to 30-39 years of age, while dancing and gymnastics exercise were more likely to be reported among those over 20 years of age. At age 60 and over, walking was the most popular exercise among both men and women.

All the possible patterns of participation in regular exercise from age 12 to the present were examined. Thirty-two

different patterns were identified (Figure 1). In men, the most common patterns were participation in regular exercise during all the age categories (12.6%) and participation in regular exercise at age 60 and over (12.6%). In women, the most common pattern was no regular exercise in any age category (21.1%), followed by participation in regular exercise at age 40 and over (14.3%).

Table 4 shows that participating in regular exercise at age 60 and over is related to participation in regular exercise across one's life span. The participants who had exercised at younger age categories were more likely to participate in exercise at age 60 and over for both men and women.

The odds ratios (OR) and 95% confidence intervals (CI) for those who regularly exercised at age 60 and over are shown in Table 5. Although, among men, the results of the unadjusted model for the age category 12-19 years

was of borderline statistical significance (OR1.42, 95% CI 0.99-2.05), the odds ratio for participating in exercise at age 60 and over was higher for men who had regular exercise during each age category. The highest odds ratio was 4.63 (95%CI 3.07-6.98) among men who had regular exercise at 40-59 years. In women, regular exercise in the earlier age categories did not correlate with exercise at age 60 and over. However, the odds ratio for participating in exercise at age 60 and over was about six times higher among those who had regular exercise at 40-59 years (OR 5.85, 95%CI 3.82-8.96). After adjusting for age (continuous variable), BMI (continuous variable), education (continuous variable), annual income (6,500,000 yen or less/more than 6,500,000 yen), work-related physical activity (1SD), smoking (never/ former/ current), self-rated health (excellent/ very good/ good/ fair/ poor) and chronic diseases (Yes/ No), the associations remained in both men and women. Regular exercise at 40-59 years was strongly associated with exercise at age 60 and over in both men (OR 5.96, 95%CI 3.72-9.57) and women (OR 6.89, 95%CI 4.23-11.23).

Table 2. Participation rate in regular exercise across the life course

age (years)	Men (n=523)		Women (n=461)		p - value
	n	%	n	%	
12-19	311	59.5	198	43.0	<0.001
20-29	173	33.1	29	6.3	<0.001
30-39	155	29.8	62	13.5	<0.001
40-59	233	44.6	203	44.0	0.871
60 and over	342	65.4	263	57.1	<0.001

Numbers and percentages are shown for those who participated in regular exercise divided into five age categories. Pearson's chi-squared test. df=1.

Discussion

The present study described regular exercise throughout a person's life and evaluated the impact of early regular exercise on participation in exercise at age 60 and over.

Previous longitudinal studies suggest that physical activity in early life tracks to later life^{5,6)}. However, most studies have tracked physical activity from childhood and adolescence to young adulthood and the coefficients re-

Table 3a. Popular types of regular exercise across the life course among men (n=523)

age (years)	1st		2nd		3rd	
		%		%		%
12-19	Baseball	16.6	Track & Field	11.9	Judo	8.4
20-29	Baseball	11.9	Softball	4.6	Table tennis	4.0
30-39	Golf	7.6	Softball	6.5	Baseball	5.9
40-59	Golf / Walking *		16.1		Softball	7.6
60 and over	Walking	34.4	Brisk walking	18.4	Golf	13.2

Percentages are shown for those who participated in the exercise. *, Both golf and walking share in 1st place with the same percentage.

Table 3b. Popular types of regular exercise across the life course among women (n=461)

age (years)	1st		2nd		3rd	
		%		%		%
12-19	Volleyball	15.8	Softball	7.8	Table tennis	6.1
20-29	Volleyball	1.7	Dancing	1.3	Tennis	0.9
30-39	Volleyball	3.5	Walking	2.8	Tennis, Dancing or Softball	1.5
40-59	Walking	13.9	Gymnastics exercise	8.7	Dancing	8.5
60 and over	Walking	24.7	Gymnastics exercise	15.4	Brisk walking	9.5

Percentages are shown for those who participated in the exercise.

Fig. 1 Participation pattern in regular exercise across the life course for men and women, separately

Regular exercise status: (○) = participants who engaged in regular exercise, (×) = participants who did not engage in regular exercise

Table 4. Distribution of participation in regular exercise at age 60 and over according to participation in regular exercise across the life course

age (years)	Regular exercise	Men (n=342)		Women (n=263)	
		n	%	n	%
12-19	No	130	61.3	144	54.8
	Yes	212	62.0	119	60.1
20-29	No	213	60.9	244	56.5
	Yes	129	74.6	19	65.5
30-39	No	225	61.4	223	56.0
	Yes	117	75.5	40	64.5
40-59	No	148	51.3	104	40.3
	Yes	194	83.3	159	78.3

Numbers and percentage are shown for those who engaged in regular exercise at age 60 and over.

ported have been only low or moderate⁵). In another study, the correlation between the time points studied was found to weaken over time¹³). Only a few studies have examined whether physical activity in early life tracks to an older age. Retrospective findings that past physical activity predicts physical activity in older people^{7,8}) can help to explain the positive association between experiences of exercise and physical activity later in life. However, basic descriptive data on individual exercise history throughout life is lacking for the community-dwelling older people in Japan. Assessing life-long regular exercise and the contribution of past exercise experience to engagement in regular exercise later in life are the underlying considerations when promoting an active lifestyle throughout a person's life.

Our finding that men are more physically active than women throughout their lives is partially supported by pre-

Table 5. Odds ratio and 95% confidence interval for those who had regular exercise at age 60 and over

	Model 1				Model 2			
	Men		Women		Men		Women	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Regular exercise								
At 12-19 years of age	1.42	0.99 - 2.05	1.30	0.89 - 1.90	1.69	1.10 - 2.58	1.06	0.71 - 1.60
At 20-29 years of age	2.03	1.35 - 3.05	1.43	0.65 - 3.14	1.87	1.21 - 2.90	1.26	0.55 - 2.87
At 30-39 years of age	2.02	1.32 - 3.09	1.47	0.84 - 2.58	2.00	1.27 - 3.15	1.29	0.69 - 2.41
At 40-59 years of age	4.63	3.07 - 6.98	5.85	3.82 - 8.96	5.96	3.72 - 9.57	6.89	4.23 - 11.23

OR, odds ratio; CI, confidence interval. Model1: unadjusted, Model2: adjusted for age, BMI, education, income, work-related physical activity, smoking, self-rated health, chronic diseases. Bold represents significant p-value (<0.05)

vious studies^{14,15}). Women may perceive more traditional, social and environmental barriers than men to engaging in exercise^{8,15}). For instance, exercise has been considered “not ladylike”¹⁶). These aspects may in part be responsible for the lower rate of participation in exercise throughout life among women. Furthermore, a large drop in participation in exercise was observed among women in their 20s and 30s. The transition from adolescence to adulthood is a period of general decline in physical activity¹⁷). Some life changes, such as getting married and having children, affect physical activity in young adulthood in women more than in men⁹). National data in Japan show that the age of first marriage for men was 26.9 years and for women 24.2 years in 1970¹⁸). The most common age range for giving birth is 20-39 years¹⁹). After the fourth decade of life, most people’s family and job situations seem to be established and stable. Retirement, in turn, tends to increase physical activity²⁰). These life events may be associated with regular exercise. Further research on the relationship between life events and exercise is needed to clarify this issue.

The most popular activities and sports changed between the earlier and later age categories; there was also a gender difference in popular types of activities throughout life. Previous studies have reported a high frequency of ball games among men across ages 14 to 31 years²¹). Dance and gymnastics were more popular with women^{15,22}). Our finding supports the previous gender difference in the traditional preferences for specific types of exercise. From the perspective of age, team sport activities were common in adolescence and young adulthood, and individual sports in middle age and older. A possible explanation of the shift is that social situations and lifestyle change according to age, for instance, it is more difficult for a large number of adults to get together, whereas individual sports can be performed in one’s own time²¹). Individual sports are sometimes labeled lifetime sports²³) and adult-like activities¹⁷). Previous studies have reported walking and gardening as the most common activities among older adults²⁴). To maintain their exercise levels, people may have to choose specific types of exercise as their lifestyles change with aging²⁵). We may consider that older people who engage in regular exercise in our study are those who are able to find suitable activities to match their life changes.

In this study, we tracked regular exercise from adolescence to age 60 and over, and described the individual variation in participation in exercise. A number of participants reported participating in regular exercise at some time in their life, although reports of consistent engagement in regular exercise across several decades were scarce. We have already shown cross-sectionally in Table 2 that the prevalence of regular exercise in the 20s and 30s was low. Figure 1 illustrates the findings as individual transitions of regular exercise throughout life. Although the percentage in each pattern was small, and the patterns of exercise frequency seemed to be similar in both men and women, we found that among men the most frequent

pattern was participation in regular exercise at all the life stages; whereas among women the most frequent pattern was no regular exercise at all. Results suggest that encouragement and support for older women should be provided by health professionals as well as the community, since participation in exercise may induce a major behavioral change among older women. There may be a need to tailor health promotion messages and interventions according to gender and personal exercise history.

After fully adjusting for confounding factors such as age, BMI, education, annual income, smoking, work-related physical activity, self-rated health, and chronic diseases, both men and women who had participated in regular exercise during 40-59 years of age had a 5 to 7-fold higher rate of participation in exercise at age 60 and over. This result suggests that participation in exercise during 40-59 years of age predicts exercise at age 60 and over. Our findings are in line with those of some previous studies^{7,8}). Frändin et al. , who studied age groups from the age of 10 years, found that physical activity during earlier life was not correlated with physical activity at the age of 76, except for the last age period 66-76 years⁷). Other studies also found the last age group to be better predictors than earlier ones^{8,26}). The short interval may be one of the causes for the strong relationship between regular exercise at 40-59 years of age and that at age 60 and over. A number of studies have suggested that childhood is usually considered the best time for socialization into physical activity⁸), for encouraging physical activity in adults through the developing of habits²⁵) and for promoting exercise-related feelings of pleasure and joy⁷). Furthermore, sports activities may have an effect on motor and coordination skills that may be of value later in life²¹). We believe that the positive effects of exercise in early life are associated with physical activity in older life. In fact, regular exercise during all the age categories studied affected exercise at age 60 and over among men. However, demographic, psychological, behavioral, social and environmental factors are associated with adulthood participation in physical activity²⁷). These multiple factors may decrease the positive effect of earlier exercise at older ages. Health problems were reported to be the most common barrier to increasing physical activity²⁸). We found that the effect of regular exercise at 40-59 years of age on participation in exercise at age 60 and over increased among women who had a history of hypertension in the sub-analyses (data not shown). Chronic health problems may also have influenced the motivation for physical activity as a part of clinical care. Our finding that regular exercise during 40-59 years of age was associated with that at age 60 and over was true for a lot of people who had not engaged in regular exercise earlier in their lives. The motivation to engage in regular exercise in the fourth and fifth decades of life may have important implications for promoting increased physical activity in older age.

This study has several limitations. The first limitation

is that our study was a retrospective study and the regular exercise data were based on self-reports. Possible memory failure and potential recall bias may have influenced the results. In addition, we were not able to take into account the short-term substitution of one exercise for another as regular exercise was defined as an activity lasting one year. Therefore our study may underestimate regular exercise as an indicator of physical activity. Secondly, social and environment factors, which have been indicated as predictors of physical activity, were not widely examined in our study. Environmental factors are among the important factors promoting participation in physical activity¹⁶⁾. Recent studies suggested that environmental problems, such as poorly lit streets or noisy traffic, are correlated with inactivity²⁹⁾. Further studies are needed to confirm the association between regular exercise and a comprehensive range of factors. Finally, the definition of regular exercise in this study was lower than the well-known recommendation of physical activity for adults by the American College of Sports Medicine³⁰⁾. However, we previously found that continuation of regular exercise by the same definition as used in this study was associated with higher muscle strength and power in both elderly men and women³¹⁾. A number of older people are physically inactive. "Tojikomori", being housebound, which has been defined in recent studies as going outdoors once or less than once a week, is a serious concern in relation to older people³²⁾. Pate et al. suggest that an active lifestyle does not require a regimented, vigorous exercise program³³⁾. To avoid causing undue stress coming from misconceptions, it may be sufficient just emphasizing to older people the importance of being physically active as opposed to having to maintain a disciplined workout schedule.

The strengths of the present study include a large number of randomized community-dwelling people and regular exercise data tracked from age 12 to 60 years and over. These data provide important information for demonstrating the value of life-long physical activity. The participants had a face-to-face interview by trained staff, which increases the reliability of the answers and reduces missing data in the questions. We were able to take into account essential social and health condition data such as education, smoking and disease as confounders. Our study described individual variation in regular exercise throughout the various stages of a person's life and showed the positive impact of experiences of exercise in earlier life on regular exercise in later life; and thus lays a good foundation for persuading the general population of the importance of maintaining physical activity throughout life.

Conclusion

The present study found that men engaged in regular exercise more than women throughout their lifetime. Exercise preferences differed depending on age and gender. Among women, those reporting no regular exercise were

the largest group. Among men, regular exercise earlier in life positively affected regular exercise at age 60 years and over. Regular exercise in middle age markedly increased participation in exercise later in life regardless of social and health conditions among both men and women.

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