

Relationship of frequency of participation in a physical checkup and physical fitness in middle-aged and elderly people: the Yakumo study

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ABSTRACT

An annual physical checkup is provided as part of the long-term Yakumo study. The checkup is voluntary and there is variation in the frequency of participation. The aim of this study was to examine relationship of physical fitness with frequency of participation in this checkup. The subjects had all attended at least one annual physical checkup from 2006 to 2018. Data from 1,804 initial checkups were used for analysis. At the checkups, age, gender, height, weight, body mass index (BMI), and bone mineral density (BMD) were recorded, and physical activity was measured. The average number of physical checkups per participant for 13 years was 2.4 (1–13). Daily exercise habits were found to be significantly associated with higher participation in physical checkups. Furthermore, between groups with low (1–5 times; <90th percentile of participants) and high (≥6 times) participation, weight and BMI were significantly higher, and BMD, grip strength, 10-m gait time, back muscle strength, and two-step test were all significantly lower in the group with lower frequency of participation in the checkup. In conclusions, our results show that frequency of participation in a voluntary annual physical checkup is significantly associated with physical fitness in middle-aged and elderly people.

Keywords: annual physical checkup, frequency of participation, middle-aged and elderly people, physical performance, Yakumo study

Abbreviations:

BMI: body mass index

BMD: bone mineral density

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INTRODUCTION

Approaches for keeping elderly people healthy are needed due to aging of Japanese society and in anticipation of upcoming aging of societies worldwide. The population aged ≥ 65 years has increased rapidly, with rates of 4.9%, 10.3%, 19.9%, and 26.0% in 1950, 1985, 2005, and 2015, respectively.¹ Furthermore, this rate is estimated to reach 30.1% in 2024 and 39.0% in 2051.² These changes are likely to lead to higher costs for nursing care, and it may be difficult to maintain a good quality of life (QOL) for all people.³ Therefore, prolongation of healthy activities of daily living (ADL) is necessary from a government perspective, as well as being useful for elderly people themselves.

Physical fitness is an important component of ADL and QOL, especially in middle-aged and elderly people.^{4,6} In extension of healthy life expectancy, physical fitness is associated with prevention of lifestyle-related diseases,² and a decrease in physical strength and physical activity associated with aging can cause a large decrease in physical fitness.⁷ Sustained physical activity is important to maintain physical fitness, and acquisition of exercise habits may affect maintenance and improvement of physical ability and acquisition of good lifestyle habits.⁸

We have conducted general screening of a residential cohort in Yakumo for many years. The “Yakumo study” includes an annual physical checkup, in which a prospective cross-sectional examination of physical fitness in middle-aged and elderly people is performed.^{4,6} The municipal government recommends that a physical checkup in middle-aged and elderly people should be performed at least once every 5 years. However, as part of our long-term cohort study, participation in a physical checkup is voluntary and there may be variation in the frequency of participation. This allows an examination of the relationship of physical fitness with frequency of participation in physical checkups, which has not been previously evaluated. Previously, in a longitudinal study, we found that physical fitness with aging had improved in a current population compared with these functions in a similar population from 15 years ago.⁹ However, the relationship of physical fitness with frequency of participation in physical checkups has not been evaluated. Therefore, the purpose of this study was to examine this relationship in middle-aged and elderly people. Understanding the significance of the frequency of participation in physical checkups may help in efforts to improve physical fitness.

MATERIALS AND METHODS

We have performed a cohort study in Yakumo for 35 years, in which a physical checkup has been held as an adjunct to a general public health checkup. The subjects were all participants who underwent an annual physical checkup in the Yakumo study for 13 years from 2006 to 2018. This checkup is performed annually in Yakumo, which is located in Hokkaido, in the north of Japan every August for four days. Medical examinations are offered to all residents aged 40 and over, and physical checkups are conducted for those who want them. The municipal government recommends a physical checkup in middle-aged and elderly people at least once every 5 years, but participation is voluntary. Subjects who participated in the physical checkup at least once from 2006 to 2018 were identified, and the number of times each subject participated and the results of their first physical fitness test were examined in this study. The total number of annual physical checkups by gender and the average age of participants are shown in Figure 1. Over 13 years, 4,349 physical checkups were performed in 1,804 participants. Background factors of age, gender, height, weight, body mass index (BMI), and bone mineral density (BMD) were also recorded. The inclusion criteria were Japanese males and females aged >40 years who underwent

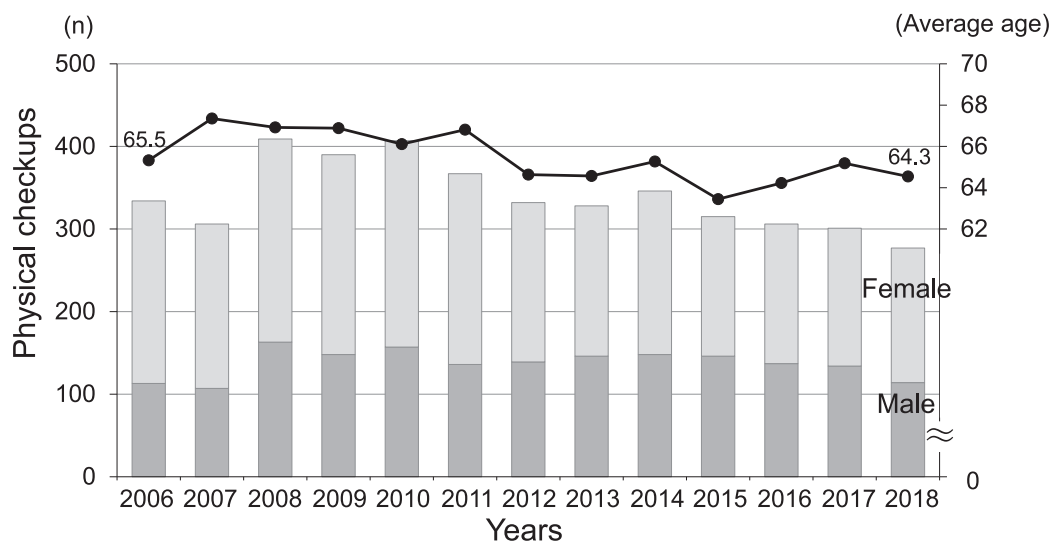


Fig. 1 Trends of physical checkups and average age

Number of physical checkups by gender (bar graph) and average age of participants (line graph). A total of 4,349 physical checkups were performed.

the physical examinations described below during the basic health checkup.^{10,11} Individuals were excluded if they had severe walking or standing disabilities or dysfunction of the central or peripheral nervous systems. Analysis was conducted from October to December 2019.

The frequency of participation in annual physical checkups was determined for all participants, and compared with their physical fitness. For a participant who attended the checkup more than once, only initial checkup data were included in the study. Of the 4,349 checkups, 2,545 were excluded as second or later checkups, leaving data from 1,804 initial checkups for analysis. Thus, these 1,804 participants are people who have undergone a physical checkup at least once. Participants were categorized in groups based on participation 1–5 times (<90th percentile of participants) and ≥ 6 times (≥ 90 th percentile). Regarding exercise habits, an interview by questionnaire was performed. For weekly exercise, information was obtained on the type of exercise, frequency per week, exercise time, and intensity of exercise. The subjects were divided into an exercise group (Ex (+)) and a group (Ex (-)) comprising those with mild physical activity (such as walking or a physical hobby) of over 2 h per week and light physical activity (without shortness of breath).^{12,13} The subjects were asked to answer “yes” or “no” to having “at least mild physical activity of over 2 h per week”. All participants provided written informed consent. The study protocol was approved by the Institutional Review Board of Nagoya University Graduate School of Medicine (No. 2014-0207), and the procedures were carried out in accordance with the principles of the Declaration of Helsinki.

Physical measurements

Bone mineral density (BMD) was measured ultrasonically in the calcaneus using a bone densitometer (A1000 Insight, Lunar Corp., Madison, WI, USA), and the percent of the young adult mean (%YAM) was measured.^{14,15} For physical fitness, grip strength was measured in a standing position using a Toei Light hand-grip dynamometer (Toei Light Co., Ltd., Saitama, Japan). Measurements were made twice, with the left and right upper limbs hanging at the side

of the body. Grip strength was obtained for each hand, and the average was used in the analysis.¹⁶ The 10-m gait time was measured to evaluate mobility, as the time required to complete a 10-m straight course at the fastest pace possible for each subject. Subjects performed the test twice, both at maximum pace, and the mean time was used for analysis.¹⁰ For back muscle strength, the maximum isometric strength of the back extensor muscles was measured in a standing position with lumbar flexion of 30° and knees extended using a digital T.K.K. 5102 dynamometer (Takei Co., Tokyo, Japan). The average force from two trials was recorded, and the maximum strength in each trial was measured. The two-step test was performed in a standing position. Subjects placed their right foot forward as far as possible and then brought their left foot up to the right foot without support. The maneuver was then repeated with the left foot stepping forward first. The test was performed twice, and the average step length divided by the height of the subject was used as the two-step test for analysis.¹⁷ All physical measurements were made by 10 orthopedic surgeons.

Statistical analysis

Differences between two groups were analyzed by Mann-Whitney U test, and Pearson chi-square test. SPSS ver. 25 for Windows (IBM, Chicago, IL) was used for all analyses, with $p < 0.05$ considered to be significant.

RESULTS

For 13 years from 2006 to 2018, 1,804 participants underwent a total of 4,349 physical checkups. The participants included 686 males and 1,118 females, and had an average age of 62.9 (40–91) years. Further demographic data are shown in Table 1. The average number of checkups per participant was 2.4 (1–13) in 13 years, based on participation in 1 (n=963), 2 (n=327), 3 (n=163), 4 (n=95), 5 (n=63), 6 (n=54), 7 (n=42), 8 (n=33), 9 (n=17), 10 (n=17), 11 (n=19), 12 (n=9) and 13 (n=2) checkups (Figure 2). There was no significant difference in the number of checkups per participant by gender.

Table 1 Demographic and physical fitness data for all participants (n=1,804)

Variable	Total (n=1,804)	Male (n=686)	Female (n=1,118)
Demographic			
Age (years)	62.8±10.5	64.5±10.0	61.7±10.7
Height (cm)	156.8±8.4	163.9±6.4	152.3±6.2
Weight (kg)	59.0±11.1	65.9±10.7	54.6±8.9
Body mass index (kg/m ²)	23.8±3.9	24.5±3.4	23.5±3.6
Bone mineral density (%YAM)	80.6±17.4	82.1±16.6	79.8±18.7
Physical fitness			
Grip strength (kg)	29.2±9.3	38.0±7.8	23.8±5.1
10-m gait time (sec)	5.6±2.1	5.4±2.4	5.7±1.8
Back muscle strength (kg)	72.1±34.0	97.5±28.6	55.7±17.7
Two-step test	1.38±0.21	1.39±0.20	1.37±0.19

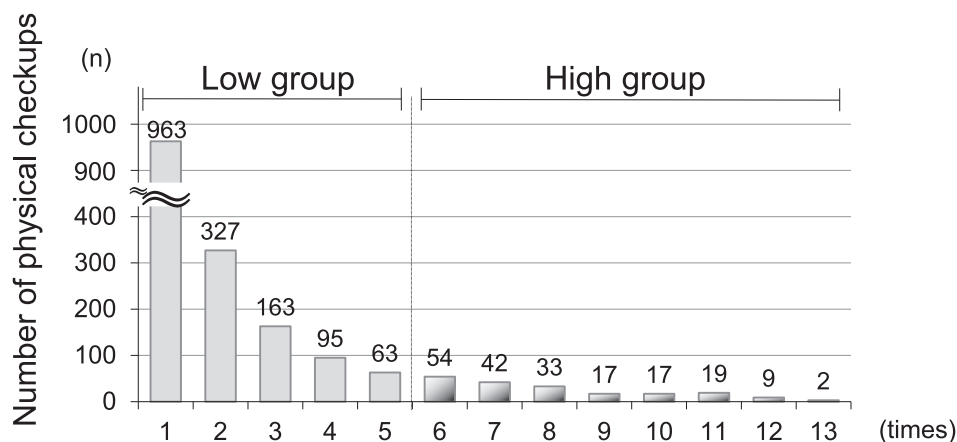


Fig. 2 Trends of number of physical checkups

Number of participants per physical checkups. Participants were categorized as having low (1–5 times, <90th percentile of participants) or high (≥ 6 times, ≥ 90 th percentile) participation in physical checkups.

In groups with low (1–5 times) and high (≥ 6 times) participation, there was no significant differences in age or height for males and females. However, there were significant differences between these groups for weight (males: 66.3 vs. 63.3 kg; females: 54.7 vs. 53.1 kg), BMI (24.6 vs. 23.4 kg/m²; 23.6 vs. 23.1 kg/m²), BMD (81.5% vs. 85.6%; 79.6% vs. 81.2%), grip strength (37.8 vs. 39.4 kg; 23.6 vs. 25.5), 10-m gait time (5.3 vs. 4.9 s; 5.8 vs. 5.2 s), back muscle strength (96.3 vs. 102.3; 55.5 vs. 59.9 kg), and two-step test (1.38 vs. 1.49; 1.37 vs. 1.44) (Table 2). A comparison of subjects with and without exercise habits is shown in Figure 3. The Ex(+) and Ex(–) groups included 288 (42%) and 398 (58%) participants, respectively. There was a significantly higher percentage of Ex(+) subjects with a high number of physical checkups (≥ 6 times) ($p < 0.01$) (Figure 3).

Table 2 Data for males and females with low (1–5 times) and high (≥ 6 times) rates of participation in physical checkups

Variables	Low (1–5 times)	High (≥ 6 times)	<i>p</i> value
Male (n=686)	(n=611)	(n=75)	
Demographic			
Age (years)	64.5 \pm 10.8	64.3 \pm 6.7	n.s.
Height (cm)	168.3 \pm 6.5	164.5 \pm 5.6	n.s.
Weight (kg)	66.3 \pm 11.1	63.3 \pm 7.3	<0.01
Body mass index (kg/m ²)	24.6 \pm 3.5	23.4 \pm 2.3	<0.01
Bone mineral density (%YAM)	81.5 \pm 16.4	85.6 \pm 16.6	<0.05
Physical fitness			
Grip strength (kg)	37.8 \pm 7.9	39.4 \pm 6.9	<0.01
10-m gait time (sec)	5.3 \pm 1.1	4.9 \pm 0.8	<0.01
Back muscle strength (kg)	96.3 \pm 27.8	102.3 \pm 26.6	<0.05

Two-step test	1.38±0.21	1.49±0.15	<0.01
Female (n=1,118)	(n=1000)	(n=118)	
Demographic			
Age (years)	61.7±10.5	62.0±7.1	n.s.
Height (cm)	152.4±6.3	151.5±4.9	n.s.
Weight (kg)	54.7±9.1	53.1±7.1	<0.05
Body mass index (kg/m ²)	23.6±3.7	23.1±2.9	<0.05
Bone mineral density (%YAM)	79.6±16.6	81.2±12.5	<0.05
Physical fitness			
Grip strength (kg)	23.6±5.1	25.5±4.8	<0.01
10-m gait time (sec)	5.8±3.5	5.2±0.8	<0.01
Back muscle strength (kg)	55.5±18.2	59.9±15.4	<0.01
Two-step test	1.37±0.20	1.44±0.15	<0.01

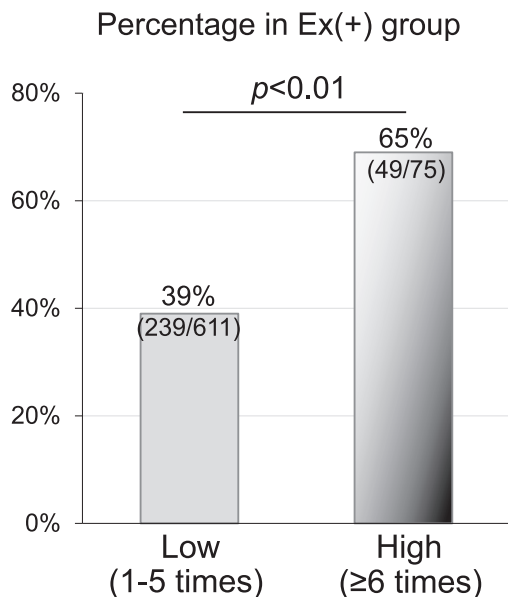


Fig. 3 Relationship between exercise habit and participation in physical checkups
There was a significantly higher percentage of Ex(+) subjects with a high number of physical checkups (≥6 times) ($p<0.01$).

DISCUSSION

With current aging of society, health problems of the elderly are important issues in Japan. Aging of the population has led to increased prevalences of various diseases, and this situation places a focus on physical function, which is strongly associated with ADL and QOL in the elderly population.^{12,18-20} In 2007, the Japanese Orthopaedic Association proposed the concept of

“locomotive syndrome”, as a condition in people with musculoskeletal disease who are highly likely to require future nursing care.^{21,22} People with locomotive syndrome have significantly lower ADL and QOL,²³ and maintaining and improving physical fitness of middle-aged and elderly people may prevent locomotive syndrome.^{22,24-27} In addition, endurance physical fitness and exercise habits are required to prevent metabolic syndrome and ischemic vascular disease.^{28,29} However, there are few prospective studies of physical fitness.

We have performed a cohort study in Yakumo for 35 years, in which a physical checkup has been held as an adjunct to a general public health checkup. Thus, the data in the current study were obtained in conjunction with medical checkups for internal medicine, otolaryngology, urology, and orthopedics, which indicates that the physical checkup can be performed with cooperation of local governments. In the town of Yakumo, the participants were healthy middle-aged and elderly people who lived in a relatively rural area, and many had jobs in agriculture or fishing. Relatively few people move into or out of the area. The municipal government recommends a physical checkup in middle-aged and elderly people at least once every 5 years. However, this checkup is voluntary, and some people participate every year, while others attend once every few years. Therefore, the frequency of participation varies. This provided an opportunity to examine the relationship of physical fitness with frequency of participation in the checkup.

The results of the study showed that people with more frequent participation in the annual physical checkup had significantly higher physical fitness, including grip strength, 10-m gait time, back muscle strength, and two-step test. These results suggest the following points. 1) Participants with high initial measurement values and confidence in their physical strength may be happy to continue with participation in physical checkups, but those with low initial values may have decreased motivation. 2) Participants who train well (people with exercise habits) are more likely to participate in physical fitness tests frequently to see the effects. 3) People with high health consciousness may also have physical strength and may more often participate in a physical checkup. Especially, middle-aged and elderly people who participated in a physical checkup more than once every 5 years might have greater health awareness, regardless of age or gender, and this might have led to maintenance and improvement of physical fitness. For middle-aged and elderly people, maintenance of strength may provide the independence necessary to participate in organized social activities.³⁰ Physical and social environmental factors may also affect physical activity.³¹ Therefore, it may be that middle-aged and older people with a higher level of health consciousness might have more frequently participated in the annual physical checkup. BMD was also significantly higher in more frequent participants, and exercise and physical activities have been recognized as significant factors that reduce the risk of osteoporosis.³² Exercise may help to maintain muscle strength, muscle volume, balance, and joint flexibility, and high-impact and/or weight-bearing exercise may increase bone density in elderly people.³³ These findings may reflect our results showing a significant relationship between frequency of participation in a physical checkup and physical fitness.

The current study has some limitations. First, the annual physical checkup is voluntary and is not required for any purpose. Thus, the number of checkups attended varied widely. Second, we did not examine medical history, content of exercise, work history, and details of medication of the participants. Also, the physical fitness examination does not include endurance, instantaneous power, balance, and flexibility, and only physical checkup data were examined for the initial checkup. In addition, it was not possible to investigate the health awareness of the participants. Thus, we cannot rule out confounding effects, and multivariate analysis was not performed. Third, it was not possible to examine the participation rate in the checkup in terms of the number of residents in the entire town. In addition, the relocation of residents in 13 years was not taken into consideration at the time of the survey. Fourth, the physical checkup in this study is a

limited physical fitness test focusing only on muscular strength and walking ability, which reflect conditions such as sarcopenia and frailty, and this may not detect high physical fitness directly. However, this is the first study to show a relationship between the frequency of participation in a physical checkup and physical fitness in a long-term prospective study. The results also showed that exercise habits are linked to frequent participation in physical checkups, and this may lead to improved physical fitness. It is important to increase the number of participants in the overall physical checkup in the future, and we are working towards this goal.

In conclusion, middle-aged and elderly people with high exercise habits had higher physical fitness and more frequently participated in a physical checkup. The frequency of participation in a voluntary annual physical checkup (at least once every two years) was significantly associated with higher physical fitness in middle-aged and elderly people. Those who frequently participated in physical checkups associated with sarcopenia and frailty also had better associated physical fitness and exercise habits. This may be because people with higher physical fitness also have higher health consciousness, which might have led to greater participation in checkups. Exercise habits might also have influenced our results.

DISCLOSURE STATEMENT

Financial support was from institutional sources only. None of the authors have a conflict of interest to declare.

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