



Original Article

# Associations between exercising in a group and physical and cognitive functions in community-dwelling older adults: a cross-sectional study using data from the Kasama Study

YUYA FUJII, MS<sup>1, 2)\*</sup>, JAEHOON SEOL, PhD<sup>3)</sup>, KAYA JOHO, MS<sup>4)</sup>, JUE LIU, MS<sup>1, 5)</sup>,  
TAIKI INOUE, MS, RPT<sup>4)</sup>, KOKI NAGATA, MS<sup>6)</sup>, TOMOHIRO OKURA, PhD<sup>7)</sup>

<sup>1)</sup> Doctoral Program in Physical Education, Health and Sport Sciences, University of Tsukuba:  
1-1-1 Tennodai, Tsukuba, Ibaraki 305-8574, Japan

<sup>2)</sup> Japan Society for the Promotion of Science, Japan

<sup>3)</sup> R&D Center for Tailor-Made QOL, University of Tsukuba, Japan

<sup>4)</sup> Doctoral Program in Human Care Science, University of Tsukuba, Japan

<sup>5)</sup> Department of Rehabilitation Medicine, Huashan Hospital Fudan University, China

<sup>6)</sup> Doctoral Program in Public Health, University of Tsukuba, Japan

<sup>7)</sup> Faculty of Health and Sport Sciences, University of Tsukuba, Japan

**Abstract.** [Purpose] To examine the associations of exercise habits, particularly exercising in a group, with physical and cognitive functions in community-dwelling older adults. [Participants and Methods] A total of 615 older adults participated in this cross-sectional study. We conducted three physical performance tests (grip strength, five times sit-to-stand, and 5-meter walk tests) and the Five-Cog test (attention, memory, visuospatial, language, and reasoning). We investigated exercise habits using questionnaires and classified the participants into three groups as follows: those who did not exercise (n=86), those who exercised alone (n=168), and those who exercised in a group (n=362). To clarify the associations of exercise habits with physical and cognitive functions, we used the analysis of covariance with adjustment for potential confounders. [Results] The participants who exercised in a group had better lower limb strength than those who exercised alone and better scores for all the variables than the non-exercisers. Furthermore, those who exercised in a group scored significantly higher on the attention, memory, visuospatial, and overall cognitive function tests than those who exercised alone. [Conclusion] Our results highlight the importance of the social aspects associated with exercising, such as the presence of exercise peers, to improve the physical and cognitive health of older adults.

**Key words:** Group exercise, Physical fitness, Cognition

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## INTRODUCTION

Regular exercise has positive effects on various health outcomes among older adults, thereby preventing functional limitation and prolonging life expectancy<sup>1-3)</sup>. Throughout the past few decades, numerous researchers have examined the health benefits of exercise to determine the optimal exercise frequency and intensity for older adults<sup>4, 5)</sup>. Hence, there are global physical activity recommendations with regard to quantitative aspects such as intensity, duration, and frequency<sup>6)</sup>.

In recent years, an increasing number of studies have focused on the effects of exercise with others (e.g., with friends or

\*Corresponding author. Yuya Fujii (E-mail: s1830465@s.tsukuba.ac.jp)

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spouses) with respect to health benefits for older adults. A review of group exercise emphasized that exercising with others carried more benefits than exercising alone; these benefits included improved exercise adherence, positive psychological factors, and stronger social relationships<sup>7</sup>). For example, previous observational studies have demonstrated that those who exercised with others reported fewer depressive symptoms, better mental well-being, better subjective health status, fewer instances of falls, and higher levels of physical activity than those who exercised alone<sup>8-13</sup>). Additionally, we previously conducted a 5 year longitudinal study to examine the effects of group exercise on the incidences of functional disability and mortality, and found that those who exercised with others tended to be at a lower risk of these outcomes<sup>14</sup>).

Although physical and cognitive functions are important predictors of the development of functional disabilities, studies examining the effects of group exercise on these two factors remain scarce. Regarding physical function, two previously conducted cross-sectional studies reported no differences between those who exercise with others and those who exercise alone<sup>9, 13</sup>). However, since those studies used self-administered questionnaires to assess physical function, measurement error and a ceiling effect can be presumed. Further studies using objective measures of physical function are necessary to clarify the association between group exercise and physical function.

Additionally, cognitive function has not been directly compared between those who exercise with others and those who exercise alone. Participation in sports groups or community salons, including light physical activity and social interaction, was associated with a lower risk of cognitive decline<sup>15, 16</sup>). Therefore, it is possible to confirm a positive relationship between exercise with others and cognitive function.

Accordingly, we investigated the associations between exercising with others and physical and cognitive functions among community-dwelling older adults. We hypothesized that older adults who exercise with others would display higher levels of physical and cognitive function than those who exercise alone or not at all.

## PARTICIPANTS AND METHODS

This cross-sectional study was based on data from the Kasama Study, which has been conducted annually since 2009 in Kasama City in rural Japan<sup>17</sup>). In the Kasama Study, older adults (aged 65 years and older) without a certification of long-term care need<sup>18</sup>) were randomly sampled and invited to receive a health checkup at one of the study sites. We combined data from the Kasama Study's reports from 2017 to 2019 into a single data set. In the case that a participant took part in this survey more than once during this period, we adopted only the data from the first participation. A total of 691 older adults participated in the study, and 75 were excluded due to missing data. As a result, data from 616 participants were included in the final analysis. The mean age of participants was  $74.2 \pm 5.2$  years, and males comprised 48.2% of the participant population.

To assess physical function, we conducted three physical performance tests: a Grip Strength test, the Five Times Sit-to-Stand test, and a 5-Meter Walk test. These three tests are known to be predictors of future development of functional disability<sup>19</sup>). Grip strength was measured twice on each hand by a grip dynamometer (TKK 5401; Takei Scientific Instruments Co., Ltd., Niigata, Japan), and the average of the better values from each hand was calculated and incorporated. To assess lower-limb muscle strength, we conducted the Five Times Sit-to-Stand test. Participants were asked to stand up and sit down in a chair five consecutive times as quickly as possible. Each participant was timed twice, and the faster record was adopted. We assessed usual gait speed using the 5-Meter Walk test. Participants were asked to walk a straight line separated into sections of 3 meters, 5 meters, and 3 meters at their usual speed, and the time spent in the middle 5 meters was measured. The test was conducted twice in a row for each participant, and the faster record was adopted.

To test cognitive function, we used the Five-Cog test developed by the International Psychogeriatric Association to detect age-associated cognitive decline<sup>20</sup>). This test consisted of the following five domains: (1) "character position referencing task" to assess attention; (2) "category cued recall task" to assess memory; (3) "clock drawing task" to assess visuospatial function; (4) "animal name listing task" to assess language; and (5) "analogy task" to assess reasoning. A higher score indicated better performance, and the sum of all domains was used as each participant's total Five-Cog score.

Current exercise habits were assessed using the following two questions: "Do you exercise on your own?" and "Do you exercise with others?". Participants were asked to select a response from the following five options for each question: "rarely", "one to three times a month", "once a week", "two to three times a week", or "four or more times a week". According to the answers, we classified participants into three groups. Those who answered "rarely" for both questions were defined as "non-exercise"; those who only exercised on their own were categorized as "exercising alone"; and those who only exercised with others or did both types of exercise were classified as "exercising with others", in accordance with previous studies<sup>8, 11, 13</sup>).

We also collected the following information from each participant: age, gender, living status (living alone or not), subjective economic condition (poor or normal/good), medical history (stroke, heart disease, and joint pain), educational status (less than high school education, high school education, or more than high school education), alcohol consumption (never, a few days a month, or once or more a week), smoking status (current smoker or not), social network, depressive symptoms, and physical activity. Additionally, body mass index (BMI) was calculated from each participant's measured height and weight. Social network was assessed by the Lubben Social Network Scale-6 (LSNS)<sup>21</sup>). This scale included six items regarding social engagement with family and friends. The scale ranged from 0 to 30, and higher point values indicated larger social network sizes. Depressive symptoms were assessed by the Geriatric Depression Scale Short Form (GDS-SF)<sup>22</sup>). This assessment consisted of 15 questions requiring "yes" or "no" answers. Higher point totals indicated higher levels of depressive

symptoms. To assess physical activity levels, we used the Physical Activity Scale for the Elderly (PASE)<sup>23</sup>. PASE included a 12-item survey regarding three domains of physical activity (leisure, household, and work-related activity) over the previous seven days. The items were weighted on the basis of intensity, and the total score was used to represent the overall physical activity level.

To compare the characteristics of each categorized exercise group, we used  $\chi^2$  tests for categorical variables and analysis of variance (ANOVA) for continuous variables. To examine the associations of exercise habits with physical and cognitive functions, we used the general linear model. Mean values for physical and cognitive functions by exercise habits were calculated using ANOVA and the analysis of covariance (ANCOVA) with two models: model 1 (adjusted for age, gender, BMI, living status, economic condition, medical history, educational status, alcohol consumption, smoking status, social network, and depressive symptoms) and model 2 (adjusted for all factors listed in model 1 plus physical activity level). Two models (with and without adjustment for physical activity level) were used because physical activity levels can be considered as both confounders and mediators. We also conducted a post-hoc test with Bonferroni adjustment in all models. All analyses were performed using IBM SPSS 26.0 (IBM Corp., Armonk, NY, USA), and the significance level was set at 5% for all.

This study was conducted in accordance with the Helsinki Statement and approved by the Ethical Committee of the University of Tsukuba (Ref No., Tai 30-5). Before the study, we explained the study's purpose to participants and obtained written informed consent from all of them.

## RESULTS

Table 1 shows participant demographics according to exercise classification. Among the 616 participants, 14.0%, 27.3%, and 58.8% were non-exercisers, those who exercised alone, and exercised with others, respectively. Differences existed among the groups with regard to economic condition, history of stroke, educational status, smoking status, social network (LSNS), depressive symptoms (GDS), and physical activity level (PASE).

Table 2 shows the associations between exercise habits and physical function. Significant group differences were confirmed for all variables. According to the post-hoc test, participants who exercised with others displayed higher levels than non-exercisers for all physical functions. Compared to those who exercised alone, those who exercised with others demon-

**Table 1.** Characteristics of participants by exercise group

Variables	Non-exercise	Exercising alone	Exercising with others	p
N (%)	86 (14.0)	168 (27.3)	362 (58.8)	
Age (years) <sup>†</sup>	74.4 (5.7)	74.9 (5.5)	73.9 (4.9)	0.07
Male (n, %)	43 (50.0)	77 (45.8)	146 (40.3)	0.19
Height (cm) <sup>†</sup>	156.6 (8.7)	156.6 (8.9)	156.2 (8.4)	0.88
Weight (kg) <sup>†</sup>	57.8 (9.2)	58.2 (10.1)	56.2 (10.6)	0.39
BMI (kg/m <sup>2</sup> ) <sup>†</sup>	23.5 (3.3)	22.8 (3.1)	22.9 (3.1)	0.15
Living alone (n, %)	9 (10.5)	23 (13.7)	37 (10.2)	0.49
Poor economic condition (n, %)	20 (23.3)	29 (17.3)	44 (12.2)	0.02
Stroke (n, %)	9 (7.0)	7 (4.2)	5 (1.4)	0.01
Heart diseases (n, %)	9 (10.5)	21 (12.5)	42 (11.6)	0.89
Joint pain (n, %)	31 (36.0)	47 (28.0)	106 (29.4)	0.38
Educational status (n, %)				0.01
Less than high school education	22 (25.6)	45 (26.8)	55 (15.2)	
High school graduate	48 (55.8)	84 (50.0)	207 (57.2)	
More than high school education	16 (18.6)	39 (23.2)	100 (27.6)	
Alcohol consumption (n, %)				0.49
Never	58 (67.4)	94 (56.0)	214 (59.1)	
Few days a month	5 (5.8)	17 (10.1)	32 (8.8)	
Once or more a week	23 (26.7)	57 (33.9)	116 (32.0)	
Current smoker (n, %)	10 (11.6)	8 (4.9)	18 (5.0)	0.05
LSNS score (point) <sup>†</sup>	16.0 (5.4)	16.4 (5.7)	19.1 (5.1)	< 0.01
GDS score (point) <sup>†</sup>	4.1 (2.9)	3.8 (3.0)	2.0 (2.8)	< 0.01
PASE score (point) <sup>†</sup>	103.8 (61.9)	120.7 (52.7)	127.5 (52.0)	< 0.01

<sup>†</sup>Each value is presented as mean (standard deviation). The p-value for differences between groups was calculated using  $\chi^2$  tests for categorical variables and analysis of variance for continuous variables. BMI: body mass index; LSNS: Lubben Social Network Scale; GDS: Geriatric depression scale; PASE: Physical Activity Scale for the Elderly.

strated better lower-limb muscle strength after adjustment for potential confounders, including physical activity. Between non-exercisers and lone exercisers, there was a significant difference in grip strength only.

Table 3 shows the associations of exercise habits with cognitive function. Compared to non-exercisers, those who exer-

**Table 2.** Mean values of physical function by exercise group

Outcomes	Non-exercise <sup>a</sup>	Exercising alone <sup>b</sup>	Exercising with others <sup>c</sup>	p	Post hoc
<b>Grip Strength (kg)</b>					
Unadjusted	26.05 (0.79)	27.22 (0.57)	27.38 (0.39)	0.32	
Model 1	25.39 (0.49)	27.28 (0.35)	27.51 (0.24)	< 0.01	a < b, c
Model 2	25.46 (0.49)	27.26 (0.35)	27.50 (0.24)	< 0.01	a < b, c
<b>5 Times Sit-to-Stand test (sec)</b>					
Unadjusted	8.62 (0.21)	8.16 (0.15)	7.40 (0.10)	< 0.01	c < a, b
Model 1	8.37 (0.20)	8.03 (0.14)	7.52 (0.10)	< 0.01	c < a, b
Model 2	8.35 (0.20)	8.03 (0.14)	7.52 (0.10)	< 0.01	c < a, b
<b>5-Meter Walk test (sec)</b>					
Unadjusted	3.82 (0.07)	3.69 (0.05)	3.44 (0.03)	< 0.01	c < a, b
Model 1	3.73 (0.07)	3.63 (0.05)	3.49 (0.03)	< 0.01	c < a
Model 2	3.72 (0.07)	3.63 (0.05)	3.49 (0.03)	< 0.01	c < a

Each value is presented as mean (standard error). Model 1: Adjusted for age, gender, BMI, living status, economic condition, medical history, educational status, alcohol consumption, smoking status, social network, and depressive symptoms. Model 2: Additional adjustment for physical activity level. Significant letters (a, b and c) indicate group differences at p<0.05 with multiple comparisons by the Bonferroni adjustment.

**Table 3.** Mean values of cognitive function by exercise group

Outcomes	Non-exercise <sup>a</sup>	Exercising alone <sup>b</sup>	Exercising with others <sup>c</sup>	p	Post hoc
<b>Attention (point)</b>					
Unadjusted	21.07 (0.87)	20.43 (0.62)	23.85 (0.42)	< 0.01	a, b < c
Model 1	22.18 (0.75)	21.40 (0.53)	23.14 (0.37)	0.03	b < c
Model 2	22.14 (0.76)	21.41 (0.54)	23.14 (0.37)	0.03	b < c
<b>Memory ability (point)</b>					
Unadjusted	15.06 (0.73)	15.48 (0.53)	18.08 (0.36)	< 0.01	a, b < c
Model 1	15.81 (0.71)	15.94 (0.50)	17.69 (0.34)	< 0.01	b < c
Model 2	15.73 (0.71)	15.96 (0.50)	17.70 (0.34)	< 0.01	a, b < c
<b>Visuospatial function (point)</b>					
Unadjusted	6.59 (0.09)	6.45 (0.07)	6.73 (0.04)	< 0.01	b < c
Model 1	6.60 (0.09)	6.46 (0.07)	6.73 (0.05)	< 0.01	b < c
Model 2	6.58 (0.09)	6.46 (0.07)	6.73 (0.05)	< 0.01	b < c
<b>Language ability (point)</b>					
Unadjusted	15.57 (0.58)	16.16 (0.41)	17.87 (0.28)	< 0.01	a, b < c
Model 1	16.24 (0.54)	16.63 (0.38)	17.50 (0.26)	0.05	
Model 2	16.18 (0.54)	16.64 (0.38)	17.51 (0.26)	0.04	
<b>Reasoning ability (point)</b>					
Unadjusted	10.51 (0.40)	10.32 (0.29)	11.17 (0.20)	0.03	b < c
Model 1	10.97 (0.35)	10.65 (0.25)	10.91 (0.17)	0.63	
Model 2	10.92 (0.36)	10.66 (0.25)	10.92 (0.17)	0.68	
<b>Total Five-Cog score (point)</b>					
Unadjusted	68.80 (2.11)	68.83 (1.51)	77.71 (1.03)	< 0.01	a, b < c
Model 1	71.80 (1.82)	71.07 (1.29)	75.96 (0.88)	< 0.01	b < c
Model 2	71.56 (1.83)	71.12 (1.29)	75.99 (0.88)	< 0.01	b < c

Each value is presented as mean (standard error). Model 1: Adjusted for age, gender, BMI, living status, economic condition, medical history, educational status, alcohol consumption, smoking status, social network, and depressive symptoms. Model 2: Additional adjustment for physical activity level. Significant letters (a, b and c) indicate group differences at p<0.05 with multiple comparisons by the Bonferroni adjustment.

cised with others demonstrated significantly better memory abilities in covariate models. Those who exercised with others scored higher for attention, memory ability, visuospatial function, and total Five-Cog score than those who exercised alone.

## DISCUSSION

In the present study, we examined the associations of exercise habits with physical and cognitive functions among older adults. Results demonstrated that those who exercised with others displayed better physical function and memory abilities than non-exercisers. Furthermore, compared to those who exercised alone, those who exercised with others displayed significantly better lower-limb muscle strength, attention, memory abilities, visuospatial function, and overall cognitive function. These results suggest that among community-dwelling older adults, exercising with others has more desirable benefits for physical and cognitive functions than exercising alone.

In similar observational studies, there were no significant differences in physical functions between those who exercised alone and those who exercised with others<sup>9, 13</sup>). However, these studies were limited in that physical function was assessed with only a self-reported questionnaire—the Motor Fitness Scale, which consists of 14 “yes” or “no” items related to mobility, strength, and balance (e.g., “I can walk up to and down from the second floor”, “I can carry something weighing 10 pounds (e.g., a 1 gallon milk bottle)”, and “I can touch the floor with my fingertips while standing with extended knees”)<sup>24</sup>). Although this scale can simply and safely assess physical function and predict the risk of functional disability<sup>25</sup>), it may not have been adequate to detect differences among exercisers due to some overestimating and ceiling effects. In our study, we used performance-based tests and clarified a positive relationship between exercising with others and physical functions, especially lower-limb muscle strength. Because improved lower-limb muscle strength significantly facilitates the effect of exercise on preventing functional limitations<sup>26</sup>), this supports our previous results that exercise with others is associated with a lower risk of functional disability<sup>14</sup>).

On the other hand, grip strength and walking ability were not significantly different between those who exercised with others and alone after adjustment for potential confounders. In the LIFE study, which followed participants over a period of 2 years, exercise intervention related to walking, strength, and balance training significantly improved lower-limb muscle strength but not hand grip strength or usual gait speed<sup>26</sup>). These results suggested that lower-limb muscle is more susceptible to the effects of exercise than the other physical functions. Additionally, a previous meta-analysis showed that the effect of exercise on hand grip strength was of relatively small magnitude among older adults<sup>27</sup>). While hand grip strength can serve as a predictor for the development of functional disability and mortality<sup>19, 28</sup>), it may not be an appropriate measure to assess the effects of exercise in older adults. In terms of usual gait speed, since the participants in this study were relatively healthy—in fact, only 2.1% displayed what is considered a slow walking speed defined by the OSHPE criteria (<1 m/s)<sup>29</sup>)—there was no significant difference between those who exercised alone and with others. From the results of these previous studies, it is reasonable that our results have confirmed a significant difference in lower-limb muscle strength only in those who exercised alone and with others.

Notably, the present study revealed that those who exercise with others demonstrate better attention, memory, visuospatial, and overall cognitive functions than those who exercise alone. Previously, regular exercise has been associated with good cognitive function<sup>30</sup>). Furthermore, participation in group sports or community salons was associated with a lower risk of cognitive impairment<sup>15, 16</sup>). Our results are in line with those from the previous study; they demonstrate the positive relationship between exercise with others and cognitive function. Furthermore, those who exercised alone did not differ from non-exercisers with regard to all cognitive variables. These results highlight the importance of participation in group exercise for maintaining good cognitive function. On the other hand, a significant difference between the non-exercisers and those who exercised with others was regarding memory. Since the total Five-Cog score for the group who exercised with others tended to be significantly higher than the non-exercise group in model 2 ( $p=0.01$ ), further research, with a large sample size, is warranted to establish associations.

Improved exercise adherence is considered to be a possible result of group exercise<sup>7</sup>). A previous study showed that group exercise may lead participants to more easily maintain their exercise adherence<sup>31</sup>); indeed, those who exercised with others displayed higher levels of physical activity; this is true both in our results and in those from the previous study<sup>13</sup>). Nevertheless, we confirmed that the associations of exercise with physical and cognitive function hardly changed, even after adjusting for the amount of physical activity. These results indicate that the amount of physical activity (calculated using intensity, duration, and frequency) does not influence the associations between exercising with others and physical and cognitive functions.

Another possible mechanism is the effect of social relationships, including social activity, social networks, and social support. These factors are inherently involved in group exercise and may contribute to the maintenance of health. For example, previous studies have shown that social relationships were positively associated with physical and cognitive functions<sup>32–34</sup>). The benefits for physical health may be incurred through the following seven psychosocial pathways set forth by Thoits’ 2011 study: social influence/social comparison, social control, role-based purpose and meaning (mattering), self-esteem, sense of control, belonging and companionship, and perceived support availability<sup>35</sup>). Regarding benefits for cognitive function, social relationships may contribute via cognitive stimulation and buffering effects of stress<sup>32</sup>). The underlying mechanisms behind the positive associations between group exercise and physical and cognitive functions remain unclear; these social



benefits may play a role.

Although our study revealed the positive associations between exercise with others and physical and cognitive functions, there are several limitations that require consideration. First, due to the cross-sectional study design, reverse causality cannot be assumed. Further longitudinal or intervention studies are needed to clarify the effects of exercise with others on physical and cognitive functions. Second, because the study population consisted only of older adults who were able to come for a physical examination, a sampling bias may be present. In fact, the exercisers made up a significant portion of the study population (>85%); this indicates that our participants tended to be healthier than the general older population. Therefore, care should be taken when generalizing the results of this study. Third, because exercise habits were self-reported, a measurement bias may exist. Although many previous studies used the same or a similar questionnaire<sup>8,9,11–14</sup>), there was no evidence regarding the validity and reliability of the measurements. Combined use of a diary and an accelerometer is necessary to confirm the actual duration and intensity of group exercise. Finally, this study did not evaluate types of exercise. Different types of exercise may be performed by those who exercise alone and those who exercise with others. Therefore, we are unable to strictly distinguish between the effects of peers and the effects of the type of exercise. In the future, we plan to compare the same type of exercise (e.g., walking, strength training, aerobic exercise, etc.) to further clarify the effects of exercise peers.

In conclusion, among community-dwelling older adults, those who exercised with others tended to display higher physical and cognitive functions than non-exercisers and those who exercised alone. These results highlight the importance of social aspects of exercise, such as the presence of exercise peers, in the promotion of health for older adults. Physical and cognitive function are crucial factors in maintaining independence; therefore, our findings may be useful in effectively promoting health in older adults. Further longitudinal studies are warranted to estimate the causal effects and establish further evidence.

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### Conflicts of interest

The authors declare no conflicts of interest associated with this manuscript.

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