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Exercise Arrangement Is Associated with Physical and Mental Health in Older Adults

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ABSTRACT

SEINO, S., A. KITAMURA, Y. TOMINE, I. TANAKA, M. NISHI, Y. TANIGUCHI, Y. YOKOYAMA, H. AMANO, Y. FUJIWARA, and S. SHINKAI. Exercise Arrangement Is Associated with Physical and Mental Health in Older Adults. *Med. Sci. Sports Exerc.*, Vol. 51, No. 6, pp. 1146–1153, 2019. **Purpose:** Although exercising with others might have health benefits, no previous study has comprehensively examined associations of exercise arrangement with physical activity (PA), physical function (PF), and mental health (MH). We examined whether PA, PF, and MH are better when exercising with others than when exercising alone or not exercising. **Methods:** We analyzed cross-sectional data from 7759 (4007 men and 3752 women) nondisabled residents age 65 to 84 yr. PA, PF, and MH were assessed with the International Physical Activity Questionnaire-Short Form (PA sufficiency defined as ≥150 min·wk^{-1} of moderate-to-vigorous PA), Motor Fitness Scale (higher PF defined as total score ≥12 in men and ≥10 in women), and World Health Organization-Five Well-Being Index (better MH defined as a total score ≥13), respectively. Exercise arrangement was classified as "nonexerciser," "exercising alone," and "exercising with others." Using multilevel logistic regression analyses, we examined independent associations of exercise arrangement with PA, PF, and MH. **Results:** Compared with exercising alone, the multivariate-adjusted odds ratios (95% confidence interval) among nonexercisers and those exercising with others were 0.21 (0.17–0.25) and 1.32 (1.04–1.67), respectively, for PA sufficiency, 0.47 (0.40–0.57) and 1.12 (0.94–1.34) for higher PF, and 0.69 (0.58–0.82) and 1.45 (1.17–1.79) for better MH, respectively, in men. In women, the corresponding odds ratios were 0.37 (0.30–0.46) and 1.31 (1.01–1.70) for PA sufficiency, 0.66 (0.54–0.80) and 1.08 (0.88–1.32) for higher PF, and 0.70 (0.58–0.85) and 1.27 (1.03–1.56) for better MH, respectively. **Conclusions:** Exercising alone and with others were better than no exercise for maintaining better PA, PF, and MH in both sexes. Although exercise arrangement had little effect on maintaining PF, exercising with others appears to enhance PA levels and MH in both sexes. **Key Words:** EXERCISE ARRANGEMENT, EXERCISING ALONE, EXERCISING WITH OTHERS, PHYSICAL ACTIVITY, PHYSICAL FUNCTION, MENTAL HEALTH

Regular physical activity (PA) confers a wide range of health benefits, such as lower rates of all-course mortality and noncommunicable diseases and higher levels of cardiorespiratory and muscular fitness, in both younger and older adults (1). Among older adults, regular PA also helps protect against frailty (2), sarcopenia (3), and cognitive decline (4). Global recommendations and guidelines on PA for older adults (1,5,6) include specific proposals regarding the type, amount, frequency, intensity, duration, and total activity level of PA that brings health benefits.

Compared with evidence with PA conditions, far fewer data are available regarding PA arrangement, such as group-based exercise (exercising with others) or exercising alone, especially among older adults. Eime et al. (7) identified four modes of leisure time PA: individual, team (club), organized, and informal. Interestingly, their systematic review of data from adults (7) showed consistent evidence that club- and team-based sport

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Submitted for publication September 2018.
Accepted for publication January 2019.
Supplemental digital content is available for this article. Direct URL citations appear in the printed text and are provided in the HTML and PDF versions of this article on the journal's Web site (www.acsm-msse.org).

0195-9131/19/5106-1146/0
MEDICINE & SCIENCE IN SPORTS & EXERCISE®

DOI: 10.1249/MSS.0000000000001884

participation was associated with better psychological and social health, as compared with other, individual forms of PA. Thus, among younger adults, robust evidence indicates that group-based sports and exercise participation yield psychosocial benefits.

To our knowledge, only four observational studies have directly compared the effects of exercising alone and exercising with others on health benefits among older adults. These studies reported that exercising with others was associated with significantly better mental health (MH) (8) and subjective health status (9), lower risk of depression (10), and fewer falls (11) than exercising alone. However, most of these studies reported psychological benefits only, and research on the relations of exercise arrangement with health benefits for older adults is at an early stage. A previous meta-analysis showed that participation in walking groups was more effective in PA promotion among older adults than among younger adults (12); thus, exercising with others may contribute to meeting recommended PA levels in older adults. However, although exercising with others may have positive effects on physical or functional variables, no study of older adults has comprehensively examined the effects of exercise arrangement on both physical health and MH.

We examined whether exercising with others increases PA, physical function (PF), and MH levels, as compared with exercising alone and no exercise, in men and women. Research in nutritional epidemiology has identified eating arrangement (i.e., eating with others) as a social aspect of health, especially in older adults (13). Because social relationships also affect PA (14), evaluating the effect of exercise arrangement on the health of older adults might add a social dimension to the present PA recommendations (i.e., regarding type, amount, frequency, intensity, duration, and total activity level of PA), which are based on medical and physiological evidence.

METHODS

Study Population

We used baseline data from a community-wide intervention study on preventing and reducing frailty in Ota City, Tokyo, Japan (Ota Genki Senior Project), which was launched in 2016 (15). The full details of the participant selection process have been previously published (15). Briefly, 15,500 residents age 65 to 84 yr—approximately 10% of elderly adults in Ota City—were selected by using stratified and random sampling strategies in all 18 districts. All participants were physically and cognitively independent, which was defined as the absence of long-term care insurance certification.

Of the 15,500 self-administered questionnaires distributed in July 2016, 11,925 were returned (response rate, 76.9%). As shown in Figure 1, 7759 questionnaires (4007 men and 3752 women) were ultimately included in our analysis. The mean district response rate was 77.1% (range, 71.8%–80.8%), and the number of respondents per district was 224 to 1915 (mean, 431).

The study protocol was developed in accordance with the guidelines proposed in the Declaration of Helsinki and was approved by the Ethical Committee of the Tokyo Metropolitan Institute of Gerontology (approved June 1, 2016). All participants gave their informed consent before their inclusion in the study.

Measurements

Physical activity. Physical activity was evaluated with the Japanese version of the International Physical Activity Questionnaire-Short Form (IPAQ-SF), the external reliability and validity of which have been reported (16,17). The IPAQ-SF includes separate items on time spent on vigorous PA, moderate PA, and walking time during a typical week. Using these values, we defined total moderate-to-vigorous PA (MVPA) as 7 d $\times$ (8.0 metabolic equivalents [METs] $\times$ vigorous PA hours per day + 4.0 METs $\times$ moderate PA hours per day + 3.3 METs $\times$ walking time hours per day) (18). A total MVPA time of more than 150 $\text{min}\cdot\text{wk}^{-1}$ was defined as PA sufficiency, in accordance with a PA recommendation (1).

Physical function. Physical function was assessed with the Motor Fitness Scale (19,20). The response to each item in this 14-item index of physical tasks is either “yes” (able to perform; 1 point) or “no” (unable to perform; 0 points). The total score ranges from 0 to 14; higher scores indicate higher PF. A total score of $\leq$11 in men and $\leq$9 in women was defined as lower PF (20). Higher PF was defined as a total score of $\geq$12 in men and $\geq$10 in women.

Mental health. Mental health was assessed by using the Japanese version of the World Health Organization-Five Well-Being Index (WHO-5) (21,22). Each item assesses the degree of positive well-being during the past 2 wk on a six-point Likert scale graded from 0 (at no time) to 5 (all of the time). The total score ranges from 0 to 25, and higher scores indicate an increased sense of well-being (22). Worse MH was defined as a total score of <13 (22). Better MH was defined a total score of $\geq$13.

Exercise Arrangement

Exercise arrangement was assessed with the following item: “Who do you usually (more than once a week) exercise with?” The possible answers were “Not exercising,” “by myself,” “spouse,” “children,” “grandchildren,” “friends of the same sex,” “friends of the opposite sex,” “exercise trainers,” or “other,” and multiple answers were allowed, with the exception of “not exercising.” Exercise arrangement was classified as “nonexerciser” (for an answer of “not exercising” only), “exercising alone” (for an answer of “by myself” only), or “exercising with others” (for the latter seven answers). When responses of “by myself” and another answer (with the exception of “not exercising”) occurred together, exercise arrangement was classified as “exercising with others,” as a reference to a previous study (23).

Covariates

The covariates included age, living situation (living with others or alone), marital status (married, widowed, divorced, or never married), duration of residence in the neighborhood

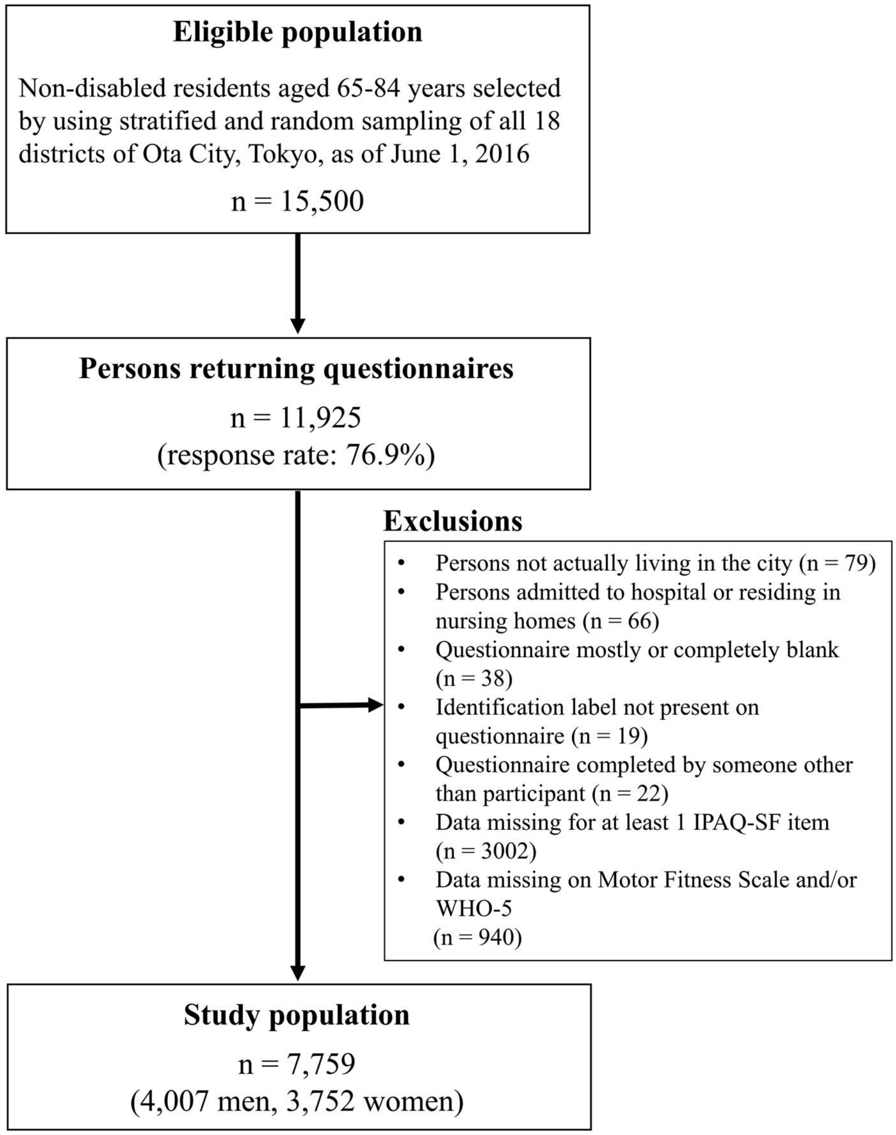

FIGURE 1—Flow diagram of study participants.

(1–29, 30–59, or ≥60 yr), educational attainment (junior high school, high school, or junior college/vocational college/college/graduate school graduation), equivalent income (<2.0, 2.0–3.99, ≥4.0 million yen, or unknown), body mass index (BMI; <18.5, 18.5–24.9, or ≥25 $kg \cdot m^{-2}$), number of chronic diseases (0, 1, or ≥2), alcohol drinking and tobacco smoking statuses (current, never, or former), social activity (presence or absence), and employment (yes or no). Equivalent income was calculated by dividing household income by the square root of the number of household members (24). Body mass index was defined as self-rated body weight (kg) divided by self-rated height squared (m^2). Number of chronic diseases was defined as the sum of the presence of self-reported hypertension, hyperlipidemia, cardiovascular disease, cerebrovascular disease, and diabetes mellitus. Participation in any of the following activities more than once a month was defined as presence of social activity: volunteering, civic action, nonprofit organizations, sports groups, hobby and learning groups, senior citizen clubs, neighborhood associations, or others (excluding employment).

If participants did not respond to the covariates, corresponding observations were assigned to the "missing" categories and included in the analysis.

Statistical Analyses

An α of 0.05 was considered to indicate statistical significance. All data were analyzed in relation to sex by using Stata 14.2 (StataCorp, TX). To examine whether PA (MVPA and minutes per week of MVPA), PF (Motor Fitness Scale score), and MH (WHO-5 score) were systematically associated with exercise arrangement (nonexerciser, exercising alone, or exercising with others), we used a trend test that extended the Wilcoxon rank-sum test (the "nptrend" command in Stata). The χ^2 test was used to compare other variables in relation to exercise arrangement categories or sex.

Because our data had a multilevel structure comprising individuals (at level 1) nested within 18 districts (at level 2), we performed multilevel logistic regression analyses with fixed slopes and random intercept models and calculated adjusted odds ratios (OR) and 95% confidence intervals (CIs) among exercise arrangement groups (nonexerciser; exercising alone, which we considered the reference group; and exercising with others) for PA sufficiency, higher PF, and better MH. PA (higher), PF (higher), and MH (better) were defined as the dependent variables. Exercise arrangement categories and covariates were defined as fixed factors. The district was defined as a random factor. We constructed four analytic models. Model 1 was adjusted for age, living situation, marital status, duration of residence in the neighborhood, educational attainment, and equivalent income. Model 2 additionally adjusted for BMI, number of chronic diseases, and alcohol drinking and smoking status. In model 3, social activity and employment status were added to model 2. In model 4, Motor Fitness Scale and WHO-5 scores were adjusted for in the analysis of PA sufficiency; MVPA and WHO-5 score were adjusted for in the analysis of higher PF; and MVPA and Motor Fitness Scale score were adjusted for in the analysis of better MH.

RESULTS

Among 4007 men, 27.7% were nonexercisers, 45.9% exercised alone, and 26.4% exercised with others. Among the 3752 women, the respective proportions were 29.9%, 30.3%, and 39.8%, and women were significantly more likely than men to exercise with others ($P < 0.001$). The Appendix (see Table, Supplemental Digital Content 1, Exercise partners, http://links.lww.com/MSS/B486) shows data on exercise partners for men and women who reported exercising with others. Among the 1058 men and 1494 women reporting exercising with others, the proportions of spouses (48.0%), grandchildren (4.6%), friends of the opposite sex (12.6%), and other (18.2%)

TABLE 1. Characteristics of male participants, according to exercising arrangement category.

Variables	All	Exercising Arrangement Category: Nonexerciser	Exercising Alone	Exercising with Others	P
	n = 4007	n = 1110 (27.7%)	n = 1839 (45.9%)	n = 1058 (26.4%)	
MVPA (MET·h·wk^{-1}), median (interquartile range)	23.1 (8.8–56.5)	8.3 (0–32.0)	27.4 (13.2–57.8)	35.6 (17.3–69.3)	<0.001[a]
Minutes per week of MVPA, median (interquartile range)	405 (150–840)	150 (0–480)	420 (210–840)	540 (285–960)	<0.001[a]
Engaging in ≥150 min·wk^{-1} of MVPA, n (%)	3066 (76.5)	573 (51.6)	1554 (84.5)	939 (88.8)	<0.001
Motor Fitness Scale (0–14), mean (SD)	10.9 (3.0)	9.6 (3.3)	11.1 (2.8)	11.7 (2.4)	<0.001[a]
Higher PF (score ≥12), n (%)	2189 (54.6)	414 (37.3)	1072 (58.3)	703 (66.5)	<0.001
WHO-5 Well-Being Index (0–25), mean (SD)	15.1 (6.0)	13.0 (6.4)	15.1 (5.9)	17.1 (5.0)	<0.001[a]
Better MH (score ≥13), n (%)	2832 (70.7)	627 (56.5)	1314 (71.5)	627 (84.2)	<0.001
Age (yr), mean (SD)	73.8 (5.4)	73.3 (5.5)	74.0 (5.4)	74.1 (5.3)	0.001[a]
Living alone, n (%)	631 (15.8)	218 (19.6)	343 (18.7)	70 (6.6)	<0.001
Marital status, n (%)					<0.001
Married	3203 (79.9)	837 (75.4)	1406 (76.5)	960 (90.7)	
Widowed or divorced	461 (11.5)	144 (13.0)	248 (13.5)	69 (6.5)	
Never married	321 (8.0)	126 (11.4)	173 (9.4)	22 (2.1)	
Years of residence in neighborhood, n (%)					0.733
1–29	799 (19.9)	213 (19.2)	374 (20.3)	212 (20.0)	
30–59	1814 (45.3)	503 (45.3)	824 (44.8)	487 (46.0)	
60-	1362 (34.0)	381 (34.3)	629 (34.2)	352 (33.3)	
Education, n (%)					<0.001
Junior high school graduation	842 (21.0)	302 (27.2)	386 (21.0)	154 (14.6)	
High school graduation	1263 (31.5)	394 (35.5)	571 (31.1)	298 (28.2)	
Junior college/vocational college/college/graduate school graduation	1807 (45.1)	379 (34.1)	839 (45.6)	589 (55.7)	
Other/missing	95 (2.4)	35 (3.2)	43 (2.3)	17 (1.6)	
Equivalent income, n (%)					<0.001
<2.0 million yen	454 (11.3)	171 (15.4)	184 (10.0)	99 (9.4)	
2.0–3.99 million yen	1435 (35.8)	433 (39.0)	679 (36.9)	323 (30.5)	
≥4.0 million yen	1312 (32.7)	334 (30.1)	622 (33.8)	356 (33.7)	
Unknown/missing	806 (20.1)	172 (15.5)	354 (19.3)	280 (26.5)	
BMI, kg·m^{-2}					<0.001
<18.5	180 (4.5)	64 (5.8)	82 (4.5)	34 (3.2)	
18.5–24.9	2855 (71.3)	723 (65.1)	1350 (73.4)	782 (73.9)	
≥25	953 (23.8)	313 (28.2)	401 (21.8)	239 (22.6)	
No. chronic diseases, n (%)[b]					0.073
0	786 (19.6)	215 (19.4)	339 (18.4)	232 (21.9)	
1	1216 (30.4)	330 (29.7)	547 (29.7)	339 (32.0)	
2^{+}	1732 (43.2)	482 (43.4)	823 (44.8)	427 (40.4)	
Alcohol drinking status, n (%)					<0.001
Current	2887 (72.1)	742 (66.9)	1336 (72.7)	809 (76.5)	
Never or former	1095 (27.3)	360 (32.4)	491 (26.7)	244 (23.1)	
Smoking status, n (%)					<0.001
Current	772 (19.3)	293 (26.4)	319 (17.4)	160 (15.1)	
Never or former	3203 (79.9)	807 (72.7)	1508 (82.0)	888 (83.9)	
Social activity, n (%)	1524 (38.0)	231 (20.8)	661 (35.9)	632 (59.7)	<0.001
Employment, n (%)	2311 (57.7)	544 (49.0)	691 (37.6)	410 (38.8)	<0.001

[a] P for trend test.
[b] Sum of the presence of hypertension, hyperlipidemia, cardiovascular disease, cerebrovascular disease, and diabetes mellitus.

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were significantly higher for men than for women (24.6%, 1.9%, 8.4%, and 12.5%, respectively). In contrast, the proportions of friends of the same sex (41.4%) and exercise trainers (43.8%) were significantly higher for women than for men (29.7% and 13.8%, respectively) ($P < 0.001$ for all comparisons).

Tables 1 and 2 show participant characteristics, in relation to exercise arrangement category, for men and women, respectively. MVPA and minutes of MVPA per week, Motor Fitness Scale score, and WHO-5 score were systematically higher in the descending order of exercising with others, exercising alone, and nonexerciser, for men and women (all $P < 0.001$ for trend). Both men and women reporting exercising with others were significantly more likely to be married, more likely to drink alcohol, had higher educational attainment and equivalent incomes, had more social activity, and were less likely to be employed, to be obese, and to smoke tobacco than were nonexercisers and/or those exercising alone. Among men, those exercising with others were significantly older than nonexercisers, whereas the opposite was true for women. Moreover, men, but not women, who reported exercising with others were significantly less likely to be living alone than were nonexercisers and those exercising alone.

Tables 3 and 4 show associations of exercise arrangement with PA sufficiency, higher PF, and better MH, as determined by multilevel logistic regression analyses of men (Table 3) and women (Table 4). In model 1, as compared with those exercising alone, nonexercisers had significantly lower ORs for PA sufficiency (men: OR, 0.19; 95% CI, 0.16–0.23; women: OR, 0.33; 95% CI, 0.27–0.41), higher PF (men: OR, 0.39; 95% CI, 0.33–0.46; women: OR, 0.53; 95% CI, 0.44–0.64), and better MH (men: OR, 0.55; 95% CI, 0.46–0.64; women: OR, 0.59; 95% CI, 0.50–0.72), and those exercising with others had significantly higher ORs for PA sufficiency (men: OR, 1.43; 95% CI, 1.14–1.81; women: OR, 1.48; 95% CI, 1.16–1.89), higher PF (men: OR, 1.33; 95% CI, 1.13–1.58; women: OR, 1.29; 95% CI, 1.07–1.55), and better MH

TABLE 2. Characteristics of female participants, according to exercising arrangement category.

		Exercising Arrangement Category			
	All	Nonexerciser	Exercising Alone	Exercising with Others	
Variables	*N* = 3752	(*n* = 1123, 29.9%)	(*n* = 1135, 30.3%)	(*n* = 1494, 39.8%)	*P*
MVPA (MET·h·wk^{-1}), median (interquartile range)	26.4 (11.6–58.0)	16.5 (5.0–44.8)	28.5 (13.2–59.6)	33.0 (17.5–66.0)	<0.001[a]
Minutes per week of MVPA, median (interquartile range)	420 (200–885)	280 (90–720)	450 (240–900)	510 (280–960)	<0.001[a]
Engaging in ≥150 min·wk^{-1} of MVPA, *n* (%)	3075 (82.0)	749 (66.7)	978 (86.2)	1348 (90.2)	<0.001
Motor Fitness Scale (0–14), mean (SD)	10.5 (3.4)	9.3 (3.7)	10.7 (3.3)	11.3 (3.0)	<0.001[a]
Higher physical function (score ≥10), *n* (%)	2538 (67.6)	612 (54.5)	791 (69.7)	1135 (76.0)	<0.001
WHO-5 Well-Being Index (0–25), mean (SD)	15.4 (5.8)	13.5 (6.4)	15.5 (5.6)	16.7 (5.0)	<0.001[a]
Better MH (score ≥13), *n* (%)	2743 (73.1)	688 (61.3)	833 (73.4)	1222 (81.8)	<0.001
Age (yr), mean (SD)	73.3 (5.5)	73.8 (5.7)	73.3 (5.4)	73.0 (5.3)	0.001[a]
Living alone, *n* (%)	915 (24.4)	241 (21.5)	355 (31.3)	319 (21.4)	<0.001
Marital status, *n* (%)					<0.001
Married	2128 (56.7)	639 (56.9)	551 (48.6)	938 (62.8)	
Widowed or divorced	1321 (35.2)	397 (35.4)	458 (40.4)	466 (31.2)	
Never married	288 (7.7)	83 (7.4)	121 (10.7)	84 (5.6)	
Years of residence in neighborhood, *n* (%)					0.138
1–29	719 (19.2)	190 (16.9)	224 (19.7)	305 (20.4)	
30–59	2226 (59.3)	671 (59.8)	660 (58.2)	895 (59.9)	
60-	786 (21.0)	255 (22.7)	243 (21.4)	288 (19.3)	
Education, *n* (%)					<0.001
Junior high school graduation	791 (21.1)	318 (28.3)	234 (20.6)	239 (16.0)	
High school graduation	1669 (44.5)	479 (42.7)	492 (43.4)	698 (46.7)	
Junior college/vocational college/college/graduate school graduation	1188 (31.7)	290 (25.8)	376 (33.1)	522 (34.9)	
Other/missing	104 (2.8)	36 (3.2)	33 (2.9)	35 (2.3)	
Equivalent income, *n* (%)					<0.001
<2.0 million yen	754 (20.1)	250 (22.3)	254 (22.4)	250 (16.7)	
2.0–3.99 million yen	1329 (35.4)	420 (37.4)	422 (37.2)	487 (32.6)	
≥4.0 million yen	1053 (28.1)	301 (26.8)	294 (25.9)	458 (30.7)	
Unknown/missing	616 (16.4)	152 (13.5)	165 (14.5)	299 (20.0)	
BMI, kg·m^{-2}					<0.001
<18.5	435 (11.6)	121 (10.8)	144 (12.7)	170 (11.4)	
18.5–24.9	2614 (69.7)	729 (64.9)	793 (69.9)	1092 (73.1)	
≥25	677 (18.0)	260 (23.2)	191 (16.8)	226 (15.1)	
No. chronic diseases, *n* (%)[b]					0.159
0	975 (26.0)	289 (25.7)	294 (25.9)	392 (26.2)	
1	1160 (30.9)	326 (29.0)	353 (31.1)	481 (32.2)	
2+	1342 (35.8)	412 (36.7)	398 (35.1)	532 (35.6)	
Alcohol drinking status, *n* (%)					<0.001
Current	1581 (42.1)	412 (36.7)	455 (40.1)	714 (47.8)	
Never or former	2149 (57.3)	700 (62.3)	671 (59.1)	778 (52.1)	
Smoking status, *n* (%)					<0.001
Current	228 (6.1)	93 (8.3)	72 (6.3)	63 (4.2)	
Never or former	3498 (93.2)	1021 (90.9)	1051 (92.6)	1426 (95.5)	
Social activity, *n* (%)	1803 (48.1)	291 (25.9)	450 (39.7)	1062 (71.1)	<0.001
Employment, *n* (%)	1010 (26.9)	346 (30.8)	336 (29.6)	328 (22.0)	<0.001

[a] *P* for trend test.
[b] Sum of the presence of hypertension, hyperlipidemia, cardiovascular disease, cerebrovascular disease, and diabetes mellitus.

TABLE 3. Multilevel logistic regression analyses of associations of exercise arrangement with PA sufficiency, higher PF, and better MH in men (n = 4007).

	Model 1			Model 2			Model 3			Model 4		
Variables	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***
For PA sufficiency												
Nonexerciser	0.19	(0.16–0.23)	<0.001	0.20	(0.17–0.24)	<0.001	0.19	(0.16–0.23)	<0.001	0.21	(0.17–0.25)	<0.001
Exercising alone	1.00	Reference		1.00	Reference		1.00	Reference		1.00	Reference	
Exercising with others	1.43	(1.14–1.81)	0.002	1.40	(1.11–1.77)	0.004	1.37	(1.08–1.74)	0.010	1.32	(1.04–1.67)	0.025
For higher PF												
Nonexerciser	0.39	(0.33–0.46)	<0.001	0.40	(0.34–0.48)	<0.001	0.41	(0.35–0.48)	<0.001	0.47	(0.40–0.57)	<0.001
Exercising alone	1.00	Reference		1.00	Reference		1.00	Reference		1.00	Reference	
Exercising with others	1.33	(1.13–1.58)	0.001	1.30	(1.10–1.55)	0.002	1.22	(1.03–1.46)	0.024	1.12	(0.94–1.34)	0.215
For better MH												
Nonexerciser	0.55	(0.46–0.64)	<0.001	0.55	(0.47–0.65)	<0.001	0.56	(0.47–0.66)	<0.001	0.69	(0.58–0.82)	<0.001
Exercising alone	1.00	Reference		1.00	Reference		1.00	Reference		1.00	Reference	
Exercising with others	1.77	(1.45–2.16)	<0.001	1.72	(1.40–2.10)	<0.001	1.52	(1.23–1.87)	<0.001	1.45	(1.17–1.79)	0.001

Model 1: Adjusted for age, living situation, marital status, years of residence in the neighborhood, education, equivalent income.
Model 2: Adjusted for variables in model 1 plus BMI, number of chronic diseases, alcohol drinking status, smoking status.
Model 3: Adjusted for variables in model 2 plus social activity and employment status.
Model 4: For sufficiency of PA, adjusted for variables in model 3 plus Motor Fitness Scale score, and World Health Organization-5 Well-Being Index score.
For higher PF, adjusted for variables in model 3 plus moderate-to-vigorous PA and World Health Organization-5 Well-Being Index score.
For better MH, adjusted for variables in model 3 plus moderate-to-vigorous PA and Motor Fitness Scale score.

(men: OR, 1.77; 95% CI, 1.45–2.16; women: OR, 1.54; 95% CI, 1.28–1.87), in both sexes.

Likewise, in model 4, the significantly lower ORs among nonexercisers for PA sufficiency (men: OR, 0.21; 95% CI, 0.17–0.25; women: OR, 0.37; 95% CI, 0.30–0.46), higher PF (men: OR, 0.47; 95% CI, 0.40–0.57; women: OR, 0.66; 95% CI, 0.54–0.80), and better MH (men: OR, 0.69; 95% CI, 0.58–0.82; women: OR, 0.70; 95% CI, 0.58–0.85) remained in both sexes (Tables 3 and 4). Among those exercising with others, the ORs for PA sufficiency (men: OR, 1.32; 95% CI, 1.04–1.67; women: OR, 1.31; 95% CI, 1.01–1.70) and better MH (OR, 1.45; 95% CI, 1.17–1.79; women: OR, 1.27; 95% CI, 1.03–1.56) were still significantly higher than those for exercising alone in model 4 in both sexes. The ORs for higher PF among those exercising with others did not significantly differ from ORs among those exercising alone in men, in model 4 (Table 3: P = 0.215), or women, in models 3 and 4 (Table 4: $P \geq 0.166$). All covariates added to model 4 were significantly positively associated with each dependent variable ($P \leq 0.039$), and bidirectional associations between PA and PF, between PF and MH, and between PA and MH were noted.

DISCUSSION

This sex-stratified multilevel logistic regression analysis yielded the following findings. First, both exercising alone and exercising with others were more effective than not exercising at all in maintaining PA sufficiency, higher PF, and better MH in both sexes. Second, exercising with others was significantly more likely than exercising alone to yield PA sufficiency and better MH in both sexes. Finally, PF did not significantly differ in men or women reporting exercising with others and those exercising alone.

Our results are consistent those of previous studies, which reported that exercising with others was positively associated with psychological benefits (8–10), and the present positive association between exercising with others and MH can be regarded as robust evidence of this association. Similarly, studies of social activities (8) and eating behaviors (13,23)

TABLE 4. Multilevel logistic regression analyses of associations of exercise arrangement with PA sufficiency, higher PF, and better MH in women (n = 3752).

	Model 1			Model 2			Model 3			Model 4		
Variables	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***	**OR**	**95% CI**	***P***
For PA sufficiency												
Nonexerciser	0.33	(0.27–0.41)	<0.001	0.33	(0.27–0.41)	<0.001	0.34	(0.27–0.42)	<0.001	0.37	(0.30–0.46)	<0.001
Exercising alone	1.00	Reference		1.00	Reference		1.00	Reference		1.00	Reference	
Exercising with others	1.48	(1.16–1.89)	0.002	1.47	(1.15–1.88)	0.002	1.34	(1.04–1.73)	0.024	1.31	(1.01–1.70)	0.039
For higher PF												
Nonexerciser	0.53	(0.44–0.64)	<0.001	0.54	(0.45–0.66)	<0.001	0.56	(0.46–0.68)	<0.001	0.66	(0.54–0.80)	<0.001
Exercising alone	1.00	Reference		1.00	Reference		1.00	Reference		1.00	Reference	
Exercising with others	1.29	(1.07–1.55)	0.008	1.26	(1.04–1.53)	0.016	1.15	(0.94–1.41)	0.166	1.08	(0.88–1.32)	0.474
For better MH												
Nonexerciser	0.59	(0.50–0.72)	<0.001	0.59	(0.49–0.72)	<0.001	0.63	(0.52–0.76)	<0.001	0.70	(0.58–0.85)	<0.001
Exercising alone	1.00	Reference		1.00	Reference		1.00	Reference		1.00	Reference	
Exercising with others	1.54	(1.28–1.87)	<0.001	1.53	(1.26–1.86)	<0.001	1.30	(1.06–1.59)	0.012	1.27	(1.03–1.56)	0.024

Model 1: Adjusted for age, living situation, marital status, years of residence in the neighborhood, education, equivalent income.
Model 2: Adjusted for variables in model 1 plus BMI, number of chronic diseases, alcohol drinking status, smoking status.
Model 3: Adjusted for variables in model 2 plus social activity and employment status.
Model 4: For sufficiency of PA, adjusted for variables in model 3 plus Motor Fitness Scale score, and World Health Organization-5 Well-Being Index score.
For higher PF, adjusted for variables in model 3 plus moderate-to-vigorous PA and World Health Organization-5 Well-Being Index score.
For better MH, adjusted for variables in model 3 plus moderate-to-vigorous PA and Motor Fitness Scale score.

observed that practicing these activities with others had a positive effect on better MH. These results suggest that psychosocial factors (e.g., reducing stress and anxiety and enhancing social connection and support) obtained through interaction with others mediate the positive effects on better MH. In addition, exercising with others may have mechanisms that differ from those of social activities and eating with others (e.g., the synergistic effects of exercise itself and interaction with others on MH), because the findings remained statistically significant in both sexes after adjustment for the presence or absence of social activity and employment status (Models 3 and 4). This point should be further examined in a future study.

A noteworthy finding of this study was that exercising with others was significantly more likely than exercising alone to lead to not only better MH, but also PA sufficiency, in both sexes. Interestingly, among the present respondents reporting exercising with others, men were more likely than women to exercise with family members, such as spouses and grandchildren (a narrower range of companions), whereas women were more likely than men to exercise with friends and exercise trainers (a broader range of companions). A systematic review (25) found that people with greater social support for PA (especially when it originated from family members) were more likely to engage in leisure-time PA and highlighted the importance of friends as a source of support for leisure-time PA in older adults. In the present study, the presence of nearby family members and friends exercising together was considered to increase directly (or indirectly through social support) adherence and PA opportunities.

The sex difference in selection of exercise companions highlights the need for attention to the differential characteristics and susceptibility of social networks between men and women. For instance, as compared with older men, older women are more likely to be embedded in diverse and large informal networks (26,27); men have fewer informal networks. Moreover, Japanese women benefited more than men from bridging social capital (i.e., resources accessed across networks with cross-social characteristics), whereas men benefited more than women from bonding social capital (i.e., resources accessed within networks or groups in which members have similar background characteristics) (28). A previous study reported sex differences in receptiveness to an intervention that increased social networks (29). Our study suggests that improving the community environment can make exercise with others more likely; however, the optimal means for promoting beneficial approaches may differ between men and women.

Our finding that PF did not differ in relation to exercise arrangement suggests that exercise intensity and frequency are more important than exercise arrangement in PF, which is plausible. However, because PA level significantly differed between those exercising alone and with others, PF may differ depending on the exercise duration. In follow-up surveys, we plan to examine longitudinally the associations observed in this study.

Our study has several limitations. First, the self-administered questionnaire used for measurement may be subject to recall bias. Although the IPAQ-SF is recommended and widely used for straightforward assessment of PA, it tends to overestimate PA, as compared with objective devices (17). Second, selection bias is a concern, as 3942 (approximately 30%) respondents were excluded because of missing data for the IPAQ-SF, Motor Fitness Scale, or WHO-5. In particular, the exclusions for missing IPAQ-SF data might have led to a larger proportion of healthier or more-active people being included in the analysis. Such people tend to exercise more and spend more time with others, which might have affected the present association between exercise arrangement and sufficiency of PA. A future study should consider conducting analysis stratified by health status. Third, although we investigated and adjusted for numerous variables, including MVPA, psychological characteristics that might affect MH could not be considered. Likewise, duration and frequency of exercising alone and with others could not be considered. Finally, the direction of causality cannot be inferred in a cross-sectional study.

Despite these limitations, this study is to our knowledge the first to report that exercising with others was more likely to lead to PA sufficiency (in addition to better MH) among older adults. Moreover, our findings are strengthened by the large sample of randomly recruited participants and the high response rate. Although some data were missing, the adjustment for PA and PF by using validated epidemiologic measurements, such as IPAQ-SF and Motor Fitness Scale, is another strength of our study.

In conclusion, this cross-sectional study confirmed that exercising alone and exercising with others were more effective than nonexercise in maintaining desirable PA, PF, and MH levels in both sexes. Although the decision to exercise alone or with others may be unimportant when aiming to maintain PF, exercising with others may further enhance PA and the psychological benefits of PA in men and women. Our findings suggest that, in addition to promoting exercise among individuals, the community environment should be improved to make exercise with others more desirable and enjoyable. Additional longitudinal data will be necessary to confirm the present associations.

This study was supported by grants from Ota City. The authors are very grateful to the residents and staff members of Ota City, as well as to our collaborators. The authors declare that the results of the present study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation, and do not constitute endorsement by the American College of Sports Medicine.

The authors declare that they have no competing interests.

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