THE GERONTOLOGICAL SOCIETY OF AMERICA®

Journals of Gerontology: Medical Sciences
cite as: *J Gerontol A Biol Sci Med Sci*, 2021, Vol. XX, No. XX, 1–8
doi:10.1093/gerona/glab101
Advance Access publication April 10, 2021

OXFORD

Research Article

Social Participation and Healthy Aging Among the Older Japanese: The Ohsaki Cohort 2006 Study

Yukai Lu, MPH,[1] Sanae Matsuyama, MS,[1] Fumiya Tanji, PhD,[2] Tatsui Otsuka, MD, PhD, MPH,[1] Yasutake Tomata, PhD,[1] and Ichiro Tsuji, MD, PhD[1,*]

[1]Division of Epidemiology, Department of Health Informatics and Public Health, Tohoku University School of Public Health, Graduate School of Medicine, Sendai, Japan. [2]Faculty of Nursing, Japanese Red Cross Akita College of Nursing, Akita, Japan.

*Address correspondence to: Ichiro Tsuji, MD, PhD, Division of Epidemiology, Department of Health Informatics and Public Health, Tohoku University School of Public Health, Graduate School of Medicine, 2-1, Seiryo-machi, Aoba-ku, Sendai, Miyagi 980-8575, Japan. E-mail: tsuji1@med.tohoku.ac.jp

Received: March 11, 2020; Editorial Decision Date: March 28, 2021

Decision Editor: Anne B. Newman, MD, MPH, FGSA

Abstract

Background: Our study examined the association between social participation and healthy aging using a community-based cohort study among Japanese older adults.

Methods: This prospective study was conducted in Ohsaki City, Japan, and included 7226 participants aged ≥65 years at the baseline survey in 2006. We obtained information on frequency of participation in 3 types of community activities (ie, neighborhood activities, hobbies, and volunteer activities) at baseline. Exposure was measured by the number of types of community activities participated in and participants were categorized into 4 groups (ie, none, 1 type, 2 types, and 3 types). The primary outcome was healthy aging as assessed by a questionnaire survey conducted in 2017, and was defined as meeting the following 4 criteria: free of disability, free of depression, high health-related quality of life, and high life satisfaction. We used multiple logistic regression models to calculate the corresponding odds ratios and 95% confidence intervals.

Results: During 11 years of follow-up, 574 (7.9%) participants attained healthy aging. Compared with participants not participating in any activity, the multivariable-adjusted odds ratios (95% confidence intervals) were 1.90 (1.40, 2.59) for those participating in 1 type, 2.49 (1.84, 3.38) for 2 types, and 3.06 (2.30, 4.07) for 3 types (p for trend < .0001). Furthermore, for each type of community activity, a higher frequency of participation was related to higher probability of healthy aging.

Conclusions: Our study suggests that social participation is associated with the promotion of healthy aging, and that the benefits were observed across different types of community activities.

Keywords: Active aging, Community activity, Healthy aging, Social activity, Successful aging

The world population is aging rapidly and the proportion of the very old is also significantly increasing. Nowadays, remaining healthy in old age no longer means the absence of physical or mental disability, but also means greater psychological and social well-being, that is, "successful aging" or "healthy aging."

Although in past decades a great deal of models and concepts of successful or healthy aging have been proposed (1–6), at present a standard definition has not been established. The most well-recognized approach was the Rowe and Kahn's model, where successful aging was defined as, "low probability of disease and disease-related disability and related risk factors," "high cognitive and physical functional capacity," and "active engagement with life" (2,3). In addition, other important theories have also been developed. For example, Baltes and Baltes proposed the selective optimization with compensation model focusing on the detailed process of successful aging (4), and Phelan et al indicated an objective-versus-subjective heterogeneity in the definition of successful aging (5).

Furthermore, in 2015, the World Health Organization began using the term "healthy ageing," defining it as "the process of developing and maintaining the functional ability that enables well-being in older age" (7). This definition emphasizes not only functionality but also recognizes the enhanced importance of promoting well-being among the older people, which includes domains such as happiness, satisfaction, and fulfillment (7). Thus, in our definition of

healthy aging, we considered not only physiological indicators (ie, free of disability) but also factors regarding psychological and social well-being (ie, free of depression, high health-related quality of life [HRQOL], and high life satisfaction).

Previous studies have indicated that people with healthier lifestyles, including not smoking, moderate consumption of alcohol, physical activity, and a healthy diet, have a higher probability of healthy aging, and that socioeconomic factors such as higher education level and higher income are also predictors of healthy aging (8–11). However, only 2 studies have examined the association between social participation and healthy aging; one of these studies reported that social participation was associated with a higher likelihood of healthy aging, whereas the other one found a null association (12,13). There is growing evidence that social participation may have a positive effect on different health outcomes such as a lower risk of disability (14–16) or mortality (17–19), better mental health (20–22), and greater well-being (23–25). Moreover, the benefits seem to be consistent among different types of community activity among the older people (14,17,19,21,26–29).

Our previous study reported that physical activities inherent to social participation reinforce the motor function required to maintain functional independence and that cognitive activities may also be involved in community activity participation and declined risk of functional disability (14). Thus, we speculated these pathways were also possible among the association between community activity and healthy aging.

Therefore, we aimed to investigate the association between social participation and multidimensional healthy aging using data from a community-based cohort study among Japanese older adults and to additionally explore the possible physical and cognitive mediators. In this study, we focused on participation in 3 different types of community activities: neighborhood activities, hobbies, and volunteer activities.

Method

Study Participants

Baseline survey

The design of the Ohsaki Cohort 2006 Study has been described in detail elsewhere (30). In brief, the source population comprised 31 694 men and women aged ≥65 years living in Ohsaki City, northeastern Japan. The baseline survey was conducted between December 1 and December 15, 2006. A questionnaire was distributed by the heads of individual administrative districts to individual households and then collected by mail. Among the source population, 23 091 persons who provided valid responses formed the study cohort. We further excluded 6333 people who did not provide written consent for review of their long-term care insurance (LTCI) information, 1979 who had already been certified as having a disability by the LTCI before follow-up, 5 who had died or moved out of the district before follow-up, and 4827 who had depression or whose responses on depression were missing at baseline. As a result, 9947 participants were followed from December 16, 2006 to November 30, 2017.

Healthy aging assessment survey (2017 Survey)

During the follow-up, 305 participants were lost because of moving out of the study area, and 2645 participants died. Among the remaining 6997 survivors, we conducted a health-related questionnaire survey at the end of November 2017 (2017 Survey). The questionnaire included self-reported questions regarding depression, HRQOL, and life satisfaction, which were the components used to assess healthy aging. The questionnaire was collected by mail. Then, we further excluded 651 participants who did not return the questionnaires or provided eligible responses, 464 whose responses on components assessing healthy aging were missing, and 1301 whose answers on participation in community activities were missing at baseline. Finally, 7226 participants, comprised of 2645 who died during follow-up and 4581 who provided valid responses in the 2017 Survey, were included in the statistical analysis (Figure 1).

Social Participation (Exposure)

At baseline, we obtained information on participation in 3 types of community activities. We asked people with 3 questions "Are you currently participating in any neighborhood activities (eg, residents associations, senior clubs, associations for children and women)? If yes, please tell us how often you are participating," "Are you currently participating in any hobbies (eg, gate ball, karaoke, lifelong learning)? If yes, please tell us how often you are participating," and "Are you currently participating in any volunteer activities (eg, community service activities, beautification activities, crime prevention, teaching children, providing child care support)? If yes, please tell us how often you are participating." They were required to choose from the following responses, "do not participate," "less than once a month," "1–3 times a month," or "more than once per week." Then, we established "No. of types of community activity" as a parameter to indicate how many types of community activity the participants had been participating in. Participants participating in a certain type of activity with a frequency of "less than once a month" or more were regarded as participating in that type of community activity. We then categorized the responses as "none," "1 type," "2 types," or "3 types."

Healthy Aging (Primary Outcome)

Functional disability ascertainment

In this study, we defined incident functional disability as certification for LTCI in Japan (Support Level 1 or higher), which uses a nationally uniform standard of functional disability (14,31–34). LTCI is a mandatory system of social insurance to assist the activities of daily living of frail older individuals. Everyone aged 40 years and older pays premiums, and everyone aged 65 years and older is eligible for formal caregiving services. LTCI certification was found to be associated with the ability to perform

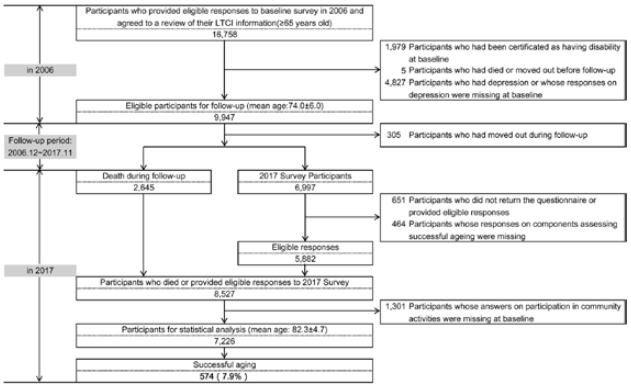

Figure 1. Flow chart of study participants.

activities of daily living in a community-based study (35) and has previously been used as a measure of incident functional disability among older individuals in epidemiologic studies (14,36,37). The data of incident functional disability, death, or emigration during follow-up were transferred from the Ohsaki City Government yearly each December under the agreement on Epidemiologic Research and Privacy Protection.

Measurement of depression

Depression was measured both at baseline and in the 2017 Survey, via the Depression and Suicide Screen. Depression and Suicide Screen is a brief screening instrument for depression and suicidal ideation for the older adults and was developed by Fujisawa et al in Japanese (38). This instrument includes 5 items: (1) "Is your life pretty full?," (2) "Do you still enjoy doing the things you used to do?," (3) "Do you think it is too much trouble to do the things you used to do?," (4) "Do you feel that you are a useful person who is needed by others?," and (5) "Do you feel tired without any specific reason?." For items 1, 2, and 4, responses of "yes" scored 1 and responses of "no" scored 0; for items 3 and 5, responses of "yes" scored 0 and responses of "no" scored 1. The cutoff of 1 (≤1 vs >1) produced satisfactory sensitivity and specificity in detecting depression (ie, 70.5% and 72.9%) (38), so we defined Depression and Suicide Screen scores of less than 2 as "free of depression."

Measurement of HRQOL

HRQOL was evaluated by the 3-level version of the European Quality of Life-5 Dimensions (EQ-5D-3L) in the 2017 Survey (39). The questionnaire included 5 dimensions: (1) mobility, (2) self-care, (3) usual activities, (4) pain/discomfort, and (5) anxiety/depression. Each of the 5 dimensions was assessed by a single question with 3 response levels (no problems, some problems, and extreme problems), thus allowing for 3^5 (ie, 243) possible health combinations overall. The Japanese version of the EQ-5D-3L was developed by Tsuchiya et al (40). The results were coded and converted to a utility value score ranging from −0.111 to 1.000. An EQ-5D-3L score of 1.000 represents a state of full health, and we defined this score as "high HRQOL."

Measurement of life satisfaction

Life satisfaction was assessed in the 2017 Survey by the Satisfaction with Life Scale (SWLS) developed by Diener et al (41), and we used the Japanese version, of which the reliability and validity were verified by Sumino (42). This scale includes 5 items and each item is scored from 1 to 7 indicating agreement, with the possible range of scores from 5 (low satisfaction) to 35 (high satisfaction). We defined SWLS scores of 25 or more as "high life satisfaction."

Definition of healthy aging

Healthy aging was the primary outcome of our study, and it consisted of 4 components: (1) free of functional disability, (2) free of depression, (3) high life satisfaction, and (4) high HRQOL. Among participants with no missing data for each component of healthy aging, only those who met all 4 criteria were considered as healthy agers. However, for those with missing data for some component(s), if they did not meet the remaining criterium(s), we defined them as normal agers. The rest were treated as having missing outcome and excluded from the statistical analysis.

Measurement of Other Variables

Body mass index was calculated as the self-reported body weight (kg) divided by the square of the self-reported body height (m^2). Education level was defined as the age at which the participants completed their education.

The Kihon Checklist was developed by the Ministry of Health, Labour, and Welfare of Japan to predict functional decline in community-dwelling older adults. As for the motor function score in the Kihon Checklist, participants were asked about their current motor function status by using 5 binary questions yielding total point scores ranging from 0 to 5, and we classified individuals with scores of <3 as having better motor function (43). For the cognitive function score, participants were asked 3 binary questions about their current subjective memory complaints and we classified individuals with scores of 0 as having better cognitive function (44).

Two factors were considered as potential mediators, time spent walking, and cognitive activity. We asked participants, "How long did you spend walking every day on average in the previous month?," which was validated in a previous study (45). We categorized the responses into 2 groups (≥1 h/day vs <1 h/day). We also collected the frequency of 7 types of cognitive activities (ie, watching TV, listening to the radio, reading a newspaper, reading magazines, reading books, playing cards or games, and going to museums) and the frequency of each type was categorized into 5 levels, with responses ranging from 1 (lower frequency) to 5 (higher frequency). We then calculated the cognitive activity score by adding up the frequency score for each type, with total scores ranging from 7 to 35 (46,47). Participants were divided into "frequently participating" (score ≤22), and "not frequently participating" (>22) based on their median cognitive activity score.

Statistical Analysis

Baseline characteristics were evaluated using the chi-squared test for variables of proportion and 1-factor analysis of variance for continuous variables. We then used multiple logistic regression models to calculate the odds ratios (ORs) and 95% confidence intervals (CIs). Participants participating in no community activities were defined as the reference group. Dummy variables were created for each multi-categorical covariate for corresponding models. For cases where values for a covariate were missing, we created a separate category for missing values and included it in the models. The following 2 models were used to analyze the association between social participation and healthy aging. Model 1 was adjusted for sex and age; Model 2 was adjusted for Model 1 plus education level, working status, body mass index, smoking status, alcohol drinking status, daily sleep duration, and history of stroke, hypertension, myocardial infarction, arthritis, osteoporosis, fracture, and cancer.

We also performed several sets of sensitivity analyses. First, we repeated multiple logistic regression analyses only for individuals who had better motor and cognitive function (motor function score <3 and cognitive function score = 0 in the Kihon Checklist) at baseline. Second, we examined the association between social participation and secondary outcomes, which were survival and the 4 components of healthy aging (ie, free of disability, free of depression, high HRQOL, and high life satisfaction), using the same multiple logistical regression models, respectively. When examining the association with each component of healthy aging, we only selected survivors with no missing values for the corresponding component. Third, we tested the interaction between sex, age (<75 years or ≥75 years), working status (working currently

or not working currently), or motor and cognitive function (both better or either worse) and social participation, and we also conducted stratification analyses according to those 4 variables. Fourth, we conducted mediation analysis using the model developed by Valeri and VanderWeele to evaluate the mediating effect of time spent walking, and cognitive activity (48). A dichotomous exposure of social participation (ie, participating in any vs not participating) was used in the mediation analyses. Fifth, because over 1000 people were excluded due to having missing values on social participation, we conducted a multiple imputation of these missing values based on age, sex, and other confounders. Five imputed data sets without missing value on social participation were created (n = 8527). Then, the corresponding logistic regression models were applied to calculating the pooled ORs (95% CIs) using the 5 imputed data sets. Last, as an attempt trying to detangle this issue, we reconducted the main analysis by treating those people with missing outcome as either healthy agers (best case assumption) and normal agers (worst case assumption), respectively.

Additionally, we repeated the analyses with secondary outcomes and stratification analyses for each type of community activity, and used the participation frequency as the exposure, respectively. The reference group for each type was participants who did not participate in that type of community activity.

All statistical analyses were performed using the SAS software package (version 9.4; SAS Institute, Inc., Cary, NC). All statistical tests were 2-sided, and differences at $p < .05$ were accepted as statistically significant.

Ethical Considerations

We considered the return of completed questionnaires to imply consent to participate in the study for the baseline survey data, subsequent follow-up of death and emigration, and 2017 Survey data. We also confirmed information regarding LTCI certification status after obtaining written consent along with the questionnaires returned from the participants at the time of the baseline survey. The Ethics Committee of Tohoku University Graduate School of Medicine (Sendai, Japan) reviewed and approved the study protocols (Ohsaki Cohort 2006 Study: 2006-206; 2017 Survey: 2017-1-631).

Results

7226 participants were included in the statistical analysis, and the average age at baseline in 2006 was 73.1 ± 5.1 years old, and 48.9% were male. During approximately 11 years of follow-up, 574 (7.9%) participants met all the criteria for healthy aging, and 5063 (70.1%) survived. Table 1 shows the baseline characteristics of participants according to the number of community activity types. Participants with a larger number of community activity types were more likely to be younger, male, have a higher education level, work currently, have better lifestyles, and have no lack of social support.

Table 2 shows the association between social participation and healthy aging. The upper part of the table indicates that compared with participants not participating in any type of community activity, the multivariable-adjusted ORs (95% CIs) were 1.90 (1.40, 2.59) for those participating in 1 type, 2.49 (1.84, 3.38) for 2 types, and 3.06 (2.30, 4.07) for 3 types (p for trend <.0001). We also repeated the analysis after excluding 2859 participants with worse cognitive and motor function at baseline. The results did not change substantially. The lower part of Table 2 shows the relationship between different types of community activity and healthy aging. Regardless of the type of community activity, people who engaged in community activities more often had significantly higher ORs of healthy aging. Also, a significant linear trend was observed among each type of community activity (p for trend <.0001 for each type). Moreover, the results remained similar for each type after we excluded participants with worse cognitive and motor function.

Table 1. Characteristics of Participants at Baseline (n = 7226)

	No. of Types of Community Activity				
	None (n = 2306)	One (n = 1620)	Two (n = 1394)	Three (n = 1906)	p Value*
Age, y (mean ± *SD*)	74.7 ± 6.3	72.8 ± 5.8	72.4 ± 5.3	71.8 ± 4.8	<.0001
Male, %	40.2	43.7	52.7	60.9	<.0001
BMI, kg/m^2 (mean ± *SD*)	23.5 ± 3.8	23.5 ± 3.2	23.7 ± 3.0	23.8 ± 3.0	.004
Education level (≥16 y), %†	63.4	74.9	77.6	83.3	<.0001
Working currently, %	35.6	38.1	41.8	42.3	<.0001
Never smokers, %	62.3	63.5	57.9	52.4	<.0001
Never drinkers, %	56.8	52.1	45.0	38.6	<.0001
Time spent walking (≥1 h/day), %	28.1	30.0	32.1	32.6	.008
Sleep duration (7–8 h/day), %	55.6	62.5	63.3	66.1	<.0001
Participating in cognitive activities frequently, %‡	37.3	54.5	60.9	71.4	<.0001
History of diseases, %					
Stroke	3.2	1.8	2.2	1.6	.003
Hypertension	58.5	55.3	52.4	54.4	.002
Myocardial infarction	4.3	4.2	4.6	3.6	.553
Arthritis	15.1	14.1	13.6	13.0	.283
Osteoporosis	10.9	9.6	7.3	5.4	<.0001
Fracture	14.2	14.2	14.6	15.5	.649
Cancers	8.5	8.2	9.0	8.5	.906

Notes: ANOVA = analysis of variance; BMI = body mass index; *SD* = standard deviation.

*p Values were calculated by using chi-squared test for variables of proportion and 1-factor ANOVA for continuous variables.

†Age when completing education.

‡Cognitive activity score ≥ 22.

Table 2. Association Between Social Participation and Healthy Aging ($n = 7226$)*

	No. of Types of Community Activity				
	None	One	Two	Three	*p* for Trend
No. of event (%)	71 (3.1)	119 (7.4)	139 (10.0)	245 (12.9)	
Model 1†	1.00 (ref.)	2.05 (1.51, 2.79)	2.75 (2.04, 3.71)	3.46 (2.62, 4.57)	<.0001
Model 2‡	1.00 (ref.)	1.90 (1.40, 2.59)	2.49 (1.84, 3.38)	3.06 (2.30, 4.07)	<.0001
	Frequency of Community Activity				*p* for Trend
	None	Less Than Once a Month	1–3 Times a Month	More Than Once Per Week	
Neighborhood activities					
No. of event (%)	184 (5.3)	126 (8.3)	175 (10.7)	89 (14.5)	
Model 1†	1.00 (ref.)	1.38 (1.09, 1.76)	1.83 (1.47, 2.28)	2.41 (1.82, 3.20)	<.0001
Model 2‡	1.00 (ref.)	1.32 (1.04, 1.69)	1.74 (1.39, 2.17)	2.12 (1.59, 2.83)	<.0001
Hobbies					
No. of event (%)	152 (4.4)	91 (9.9)	131 (9.3)	200 (14.3)	
Model 1†	1.00 (ref.)	2.00 (1.52, 2.64)	1.91 (1.49, 2.45)	3.06 (2.45, 3.84)	<.0001
Model 2‡	1.00 (ref.)	1.88 (1.42, 2.49)	1.77 (1.38, 2.28)	2.76 (2.18, 3.49)	<.0001
Volunteer activities					
No. of event (%)	254 (5.5)	129 (10.2)	114 (12.9)	77 (16.5)	
Model 1†	1.00 (ref.)	1.58 (1.26, 1.98)	2.03 (1.60, 2.58)	2.65 (1.99, 3.52)	<.0001
Model 2‡	1.00 (ref.)	1.49 (1.18, 1.87)	1.85 (1.45, 2.37)	2.36 (1.76, 3.16)	<.0001

Notes: *Odds ratios (95% confidence intervals) were calculated by logistic regression models.

†Model 1 was adjusted for sex and age (65–69, 70–74, 75–79, 80–84, or ≥85 years).

‡Model 2 was adjusted for Model 1 plus education level (age at completion of education: <16 years, ≥16 years, or missing), working currently (yes, no, or missing), body mass index (<18.5 kg/m^2, 18.5–25 kg/m^2, ≥25 kg/m^2, or missing), smoking status (never smokers, current smokers, ex-smokers, or missing), alcohol drinking status (never drinkers, current drinkers, ex-drinkers, or missing), sleep duration (<7 hours, 7–8 hours, >8 hours, or missing), and history of diseases (stroke, hypertension, myocardial infarction, arthritis, osteoporosis, fracture, and cancers; yes or no).

Table 3 shows the association between social participation and the secondary outcomes of survival, free of disability, free of depression, high HRQOL, and high life satisfaction. Compared with participants participating in no activities, the multivariable-adjusted hazard ratio (95% CI) of survival was 1.51 (1.29, 1.76) for those participating 1 type of activity, 1.56 (1.32, 1.85) for 2 types, and 1.81 (1.54, 2.12) for 3 types (p for trend <.0001). Similar results were also found when using the 4 components of healthy aging as the secondary outcomes.

Figure 2 shows the results of mediating effects of time spent walking, and cognitive activity. A relatively large mediating effect was observed for cognitive activity (11.0%) but not for time spent walking (0.5%). Regarding the results of stratification analyses by sex, age, working status, or motor and cognitive function, no interaction was found for any of these variables (see Supplementary Table 2).

Furthermore, after multiple imputations the pooled ORs were found similar to the results shown in Table 2 (see Supplementary Table 1). Additionally, we repeated the analyses with the secondary outcomes and stratification analyses according to sex, age, and working status for each type of community activity. However, the results did not change substantially (see Supplementary Tables 3–8).

Discussion

In summary, participants who engaged in a larger number of community activity had a significantly higher probability of healthy aging. The results also indicated that, for each type of community activity, participating more frequently was associated with a greater likelihood of healthy aging.

Previous studies have examined the relationship between social participation and outcomes closely related to our definition of healthy aging. For instance, previous studies have reported that social participation is associated with lower risk of mortality and disability (14,17). Also, social participation was found to protect against depression due to social support from informal social networks (20–22). On the other hand, few studies have investigated the relationship between social participation and HRQOL or life satisfaction. Two Korean studies indicated a positive association between an increase in the number of community activities and an increase in HRQOL (23), and that continuing participation in community activities had a positive impact on life satisfaction (24). This is consistent with our findings when we used survival and the 4 components of healthy aging as the secondary outcomes. Nevertheless, considering the disparities in the definitions of exposures and outcomes, caution should be exercised when comparing our study with previous ones.

We also investigated the association between the frequency of different types of community activity and healthy aging. There was a clear linear trend for frequency of neighborhood and volunteer activities with healthy aging. However, participation in hobbies at frequencies of "less than once a month" and "1–3 times a month" showed similar ORs of healthy aging. A previous study reported that different hobbies may contribute to health differently (19); thus, a variety of hobbies which we could not distinguish in the present study could have different impacts on healthy aging.

It was indicated that the relationship between social participation and incident disability was partially mediated by time spent walking, or cognitive activity (14). Therefore, we conducted mediation analyses to investigate whether there were mediating effects of these factors in the relationship with healthy aging, and we found a relatively larger mediating effect for cognitive activity. Cognitive activities were found to be connected with promoting cognitive health (46,47), which then contributed to healthy aging.

Table 3. Association Between No. of Types of Community Activity and Secondary Outcomes*

	No. of Types of Community Activity				
	None	One	Two	Three	*p* for Trend
Survival (*n* = 7226)					
No. of event (%)	1384 (60.0)	1180 (72.8)	1029 (73.8)	1470 (77.1)	
Model 1†	1.00 (ref.)	1.58 (1.35, 1.84)	1.72 (1.46, 2.02)	2.08 (1.78, 2.42)	<.0001
Model 2‡	1.00 (ref.)	1.51 (1.29, 1.76)	1.56 (1.32, 1.85)	1.81 (1.54, 2.12)	<.0001
Free of disability (*n* = 5063)					
No. of event (%)	810 (58.5)	800 (67.8)	728 (70.8)	1107 (75.3)	
Model 1†	1.00 (ref.)	1.26 (1.05, 1.51)	1.32 (1.09, 1.59)	1.54 (1.29, 1.84)	<.0001
Model 2‡	1.00 (ref.)	1.22 (1.01, 1.46)	1.23 (1.01, 1.49)	1.42 (1.18, 1.71)	.0003
Free of depression (*n* = 3868)					
No. of event (%)	436 (45.6)	500 (55.7)	479 (58.6)	764 (63.9)	
Model 1†	1.00 (ref.)	1.35 (1.12, 1.63)	1.47 (1.21, 1.79)	1.83 (1.52, 2.20)	<.0001
Model 2‡	1.00 (ref.)	1.30 (1.07, 1.58)	1.39 (1.13, 1.70)	1.72 (1.42, 2.08)	<.0001
High HRQOL (*n* = 4131)					
No. of event (%)	241 (23.3)	311 (32.3)	286 (33.0)	447 (35.3)	
Model 1†	1.00 (ref.)	1.42 (1.16, 1.75)	1.39 (1.13, 1.71)	1.45 (1.20, 1.76)	.0009
Model 2‡	1.00 (ref.)	1.39 (1.13, 1.70)	1.36 (1.10, 1.68)	1.44 (1.18, 1.75)	.002
High life satisfaction (*n* = 4067)					
No. of event (%)	280 (27.3)	316 (33.4)	343 (40.3)	625 (50.3)	
Model 1†	1.00 (ref.)	1.33 (1.10, 1.61)	1.77 (1.45, 2.15)	2.63 (2.19, 3.15)	<.0001
Model 2‡	1.00 (ref.)	1.30 (1.07, 1.58)	1.69 (1.38, 2.06)	2.51 (2.08, 3.02)	<.0001

Notes: HRQOL = health-related quality of life.

*Odds ratios (95% confidence intervals) were calculated by logistic regression models.

†Model 1 was adjusted for sex and age (65–69, 70–74, 75–79, 80–84, or ≥85 years).

‡Model 2 was adjusted for Model 1 plus education level (age at completion of education: <16 years, ≥16 years, or missing), working currently (yes, no, or missing), body mass index (<18.5 kg/m^2, 18.5–25 kg/m^2, ≥25 kg/m^2, or missing), smoking status (never smokers, current smokers, ex-smokers, or missing), alcohol drinking status (never drinkers, current drinkers, ex-drinkers, or missing), sleep duration (<7 hours, 7–8 hours, >8 hours, or missing), and history of diseases (stroke, hypertension, myocardial infarction, arthritis, osteoporosis, fracture, and cancers; yes or no).

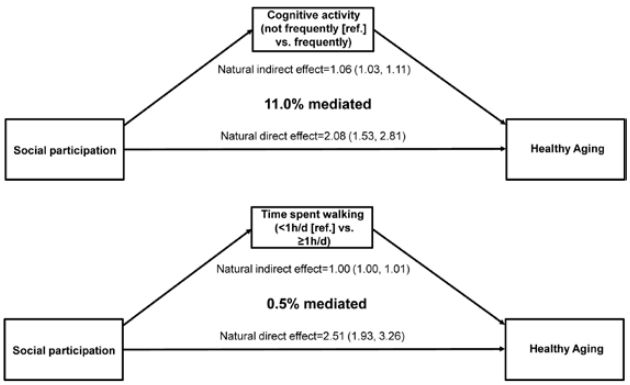

Figure 2. Mediating analysis on the association between social participation and healthy aging. *Notes*: This model was adjusted for sex and age (65–69, 70–74, 75–79, 80–84, or ≥85 years), education level (age at completion of education: <16 years, ≥16 years, or missing), working currently (yes, no, or missing), body mass index (<18.5 kg/m^2, 18.5–25 kg/m^2, ≥25 kg/m^2, or missing), smoking status (never smokers, current smokers, ex-smokers, or missing), alcohol drinking status (never drinkers, current drinkers, ex-drinkers, or missing), sleep duration (<7 hours, 7–8 hours, >8 hours, or missing), and history of diseases (stroke, hypertension, myocardial infarction, arthritis, osteoporosis, fracture, and cancers; yes or no). Exposure–mediator interactions were tested in advance but nonsignificant; therefore, exposure–mediator interactions were not included in the results and control direct effect was equaled to natural direct effect.

However, further studies are still needed to explore the role of cognitive activity in achieving healthy aging among the older population.

Our study has some limitations that should be mentioned. First, we excluded participants with depression, but we could not obtain information about HRQOL and life satisfaction at baseline. Second, the questionnaire on social participation had not been evaluated for reliability and validity. For each type of community activity, we only provided several examples within each question but did not ask them further about their participation of those example activities. Third, some participants were excluded from statistical analysis due to missing data for component(s) defining healthy aging. In an attempt to detangle this issue, we reconducted the main analysis by treating those people with missing outcomes as healthy agers and normal agers, respectively. When we treated them as normal agers, the results did not change; however, when we treated them as healthy agers, the results attenuated but had the same trend of association (see Supplementary Tables 9 and 10). We considered that the present results were robust over the wide range of assumptions. Forth, we considered many covariates in the analyses, but residual confounding still may influence our results, such as socioeconomic status. Last, although multiple sensitivity analyses showed consistent results, we could not fully rule out the potential for reverse causation that healthier people generally are more likely to be socially engaged than unhealthy people. Despite of all the limitations, our study still has some strengths. First, we followed a relatively large number of study participants for a long period, with a low rate lost to follow-up. Second, in our definition of healthy aging we considered not only physiological indicators, but also psychological indicators, which were neglected in previous studies.

Our study was consistent with previous studies showing that social participation was associated with healthy aging, including longevity, physical and psychological health, and well-being (14–25). Moreover,

the positive effect of community activities was observed even among those with poor motor or cognitive function at baseline, suggesting that relatively "vulnerable" older adults may also attain healthy aging through social participation. A report from Japan has confirmed the effectiveness of community centers in promoting social participation and maintaining a higher level of functions among older people (49). Thus, we suggest policy makers provide more opportunities and resources for community activities in order to promote healthy aging among older people, including those with poor function.

In conclusion, our study suggests social participation appears to have great benefits on promoting healthy aging, and the benefits were observed consistently among different types of community activities.

Supplementary Material

Supplementary data are available at *The Journals of Gerontology, Series A: Biological Sciences and Medical Sciences* online.

Funding

This work was supported by JSPS KAKENHI grant number 17H04130. Y.L. received financial support from the Otsuka Toshimi Scholarship on the period of 2019–2021.

Conflict of Interest

None declared.

Author Contributions

I.T. designed the research; Y.T. and I.T. conducted the research; Y.L., S.M., and F.T. analyzed the data; Y.L. wrote the paper; S.M., F.T., T.O., Y.T., and I.T. gave the constructive suggestions. I.T. had primary responsibility for the final content. All authors read and approved the final manuscript.

References

1. Havighurst RJ. Successful aging. *Gerontologist*. 1961;1:8–13. doi:10.1093/geront/1.1.8
2. Rowe JW, Kahn RL. Human aging: usual and successful. *Science*. 1987;237:143–149. doi:10.1126/science.3299702
3. Rowe JW, Kahn RL. Successful aging. *Gerontologist*. 1997;37:433–440. doi:10.1093/geront/37.4.433
4. Baltes PB, Baltes MM. Psychological perspectives on successful aging: the model of selective optimization with compensation. In: Baltes MM, Baltes PB, eds. *Successful Aging*. Cambridge: Cambridge University Press; 1990:1–34.
5. Phelan EA, Anderson LA, LaCroix AZ, Larson EB. Older adults' views of "successful aging"—how do they compare with researchers' definitions? *J Am Geriatr Soc*. 2004;52:211–216. doi:10.1111/j.1532-5415.2004.52056.x
6. Lu W, Pikhart H, Sacker A. Domains and measurements of healthy aging in epidemiological studies: a review. *Gerontologist*. 2019;59:e294–e310. doi:10.1093/geront/gny029
7. World Health Organization. *World Report on Ageing and Health*. World Health Organization; 2015.
8. Depp CA, Jeste DV. Definitions and predictors of successful aging: a comprehensive review of larger quantitative studies. *Am J Geriatr Psychiatry*. 2006;14:6–20. doi:10.1097/01.JGP.0000192501.03069.bc
9. Sabia S, Singh-Manoux A, Hagger-Johnson G, Cambois E, Brunner EJ, Kivimaki M. Influence of individual and combined healthy behaviours on successful aging. *CMAJ*. 2012;184:1985–1992. doi:10.1503/cmaj.121080
10. Gopinath B, Flood VM, Kifley A, Louie JC, Mitchell P. Association between carbohydrate nutrition and successful aging over 10 years. *J Gerontol A Biol Sci Med Sci*. 2016;71:1335–1340. doi:10.1093/gerona/glw091
11. Gopinath B, Russell J, Kifley A, Flood VM, Mitchell P. Adherence to dietary guidelines and successful aging over 10 years. *J Gerontol A Biol Sci Med Sci*. 2016;71:349–355. doi:10.1093/gerona/glv189
12. Hodge AM, English DR, Giles GG, Flicker L. Social connectedness and predictors of successful ageing. *Maturitas*. 2013;75:361–366. doi:10.1016/j.maturitas.2013.05.002
13. Sowa A, Tobiasz-Adamczyk B, Topor-Madry R, Poscia A, la Milia DI. Predictors of healthy ageing: public health policy targets. *BMC Health Serv Res*. 2016;16(suppl 5):289. doi:10.1186/s12913-016-1520-5
14. Otsuka T, Tomata Y, Zhang S, et al. Association between social participation and incident risk of functional disability in elderly Japanese: the Ohsaki Cohort 2006. *J Psychosom Res*. 2018;111:36–41. doi:10.1016/j.jpsychores.2018.05.004
15. Gao M, Sa Z, Li Y, et al. Does social participation reduce the risk of functional disability among older adults in China? A survival analysis using the 2005–2011 waves of the CLHLS data. *BMC Geriatrics*. 2018;18:224. doi:10.1186/s12877-018-0903-3
16. James BD, Boyle PA, Buchman AS, Bennett DA. Relation of late-life social activity with incident disability among community-dwelling older adults. *J Gerontol A Biol Sci Med Sci*. 2011;66:467–473. doi:10.1093/gerona/glq231
17. Okura M, Ogita M, Yamamoto M, Nakai T, Numata T, Arai H. Community activities predict disability and mortality in community-dwelling older adults. *Geriatr Gerontol Int*. 2018;18:1114–1124. doi:10.1111/ggi.13315
18. Krokstad S, Ding D, Grunseit AC, et al. Multiple lifestyle behaviours and mortality, findings from a large population-based Norwegian cohort study—the HUNT Study. *BMC Public Health*. 2017;17:58. doi:10.1186/s12889-016-3993-x
19. Fushiki Y, Ohnishi H, Sakauchi F, Oura A, Mori M. Relationship of hobby activities with mortality and frailty among community-dwelling elderly adults: results of a follow-up study in Japan. *J Epidemiol*. 2012;22:340–347. doi:10.2188/jea.je20110057
20. Chiao C, Weng LJ, Botticello AL. Social participation reduces depressive symptoms among older adults: an 18-year longitudinal analysis in Taiwan. *BMC Public Health*. 2011;11:292. doi:10.1186/1471-2458-11-292
21. Okura M, Ogita M, Yamamoto M, Nakai T, Numata T, Arai H. The relationship of community activities with cognitive impairment and depressive mood independent of mobility disorder in Japanese older adults. *Arch Gerontol Geriatr*. 2017;70:54–61. doi:10.1016/j.archger.2016.12.010
22. Choi Y, Park EC, Kim JH, Yoo KB, Choi JW, Lee KS. A change in social activity and depression among Koreans aged 45 years and more: analysis of the Korean Longitudinal Study of Aging (2006–2010). *Int Psychogeriatr*. 2015;27:629–637. doi:10.1017/S1041610214002439
23. Park HK, Chun SY, Choi Y, Lee SY, Kim SJ, Park EC. Effects of social activity on health-related quality of life according to age and gender: an observational study. *Health Qual Life Outcomes*. 2015;13:140. doi:10.1186/s12955-015-0331-4
24. Choi Y, Lee KS, Shin J, Kwon JA, Park EC. Effects of a change in social activity on quality of life among middle-aged and elderly Koreans: analysis of the Korean longitudinal study of aging (2006–2012). *Geriatr Gerontol Int*. 2017;17:132–141. doi:10.1111/ggi.12685
25. Vozikaki M, Linardakis M, Micheli K, Philalithis A. Activity participation and well-being among European adults aged 65 years and older. *Soc Indic Res*. 2017;131:769–795. doi:10.1007/s11205-016-1256-y
26. Tomioka K, Kurumatani N, Hosoi H. Association between social participation and instrumental activities of daily living among community-dwelling older adults. *J Epidemiol*. 2016;26:553–561. doi:10.2188/jea.JE20150253
27. Carr DC, Kail BL, Rowe JW. The relation of volunteering and subsequent changes in physical disability in older adults. *J Gerontol B Psychol Sci Soc Sci*. 2018;73:511–521. doi:10.1093/geronb/gbx102
28. Griep Y, Hanson LM, Vantilborgh T, Janssens L, Jones SK, Hyde M. Can volunteering in later life reduce the risk of dementia? A 5-year longitudinal study among volunteering and non-volunteering retired seniors. *PLoS One*. 2017;12:e0173885. doi:10.1371/journal.pone.0173885

29. Tabassum F, Mohan J, Smith P. Association of volunteering with mental well-being: a lifecourse analysis of a national population-based longitudinal study in the UK. *BMJ Open*. 2016;6:e011327. doi:10.1136/bmjopen-2016-011327
30. Kuriyama S, Nakaya N, Ohmori-Matsuda K, et al. The Ohsaki Cohort 2006 study: design of study and profile of participants at baseline. *J Epidemiol*. 2010;20:253–258. doi:10.2188/jea.JE20090093
31. Ministry of Health, Labour and Welfare. *Long-Term Care, Health and Welfare Services for the Elderly*. 2017. https://www.mhlw.go.jp/english/policy/care-welfare/care-welfare-elderly/index.html. Accessed May 4, 2021.
32. Ikegami N. Public long-term care insurance in Japan. *JAMA*. 1997;278:1310–1314. doi:10.1001/jama.278.16.1310
33. Tsutsui T, Muramatsu N. Care-needs certification in the long-term care insurance system of Japan. *J Am Geriatr Soc*. 2005;53:522–527. doi:10.1111/j.1532-5415.2005.53175.x
34. Imahashi K, Kawagoe M, Eto F, Haga N. Clinical status and dependency of the elderly requiring long-term care in Japan. *Tohoku J Exp Med*. 2007;212:229–238. doi:10.1620/tjem.212.229
35. Arai Y, Zarit SH, Kumamoto K, Takeda A. Are there inequities in the assessment of dementia under Japan's LTC insurance system? *Int J Geriatr Psychiatry*. 2003;18:346–352. doi:10.1002/gps.836
36. Bando S, Tomata Y, Aida J, Sugiyama K, Sugawara Y, Tsuji I. Impact of oral self-care on incident functional disability in elderly Japanese: the Ohsaki Cohort 2006 study. *BMJ Open*. 2017;7:e017946. doi:10.1136/bmjopen-2017-017946
37. Lu Y, Sugawara Y, Zhang S, Tomata Y, Tsuji I. Changes in sleep duration and the risk of incident dementia in the elderly Japanese: the Ohsaki Cohort 2006 Study. *Sleep*. 2018;41. doi:10.1093/sleep/zsy143.
38. Fujisawa D, Tanaka E, Sakamoto S, Neichi K, Nakagawa A, Ono Y. The development of a brief screening instrument for depression and suicidal ideation for elderly: the Depression and Suicide Screen. *Psychiatry Clin Neurosci*. 2005;59:634–638. doi:10.1111/j.1440-1819.2005.01429.x
39. EuroQol Group. Euroqol—a new facility for the measurement of health-related quality-of-life. *Health Policy*. 1990;16:199–208.
40. Tsuchiya A, Ikeda S, Ikegami N, et al. Estimating an EQ-5D population value set: the case of Japan. *Health Econ*. 2002;11:341–353. doi:10.1002/hec.673
41. Diener E, Emmons RA, Larsen RJ, Griffin S. The Satisfaction with Life Scale. *J Pers Assess*. 1985;49:71–75. doi:10.1207/s15327752jpa4901_13
42. Sumino Z. [Development of Japanese version of the Satisfaction with Life Scale (SWLS)]. Annual Convention of the Japanese Association of Educational Psychology. 1994;36:192. doi:10.20587/pamjaep.36.0_192
43. Tomata Y, Hozawa A, Ohmori-Matsuda K, et al. [Validation of the Kihon Checklist for predicting the risk of 1-year incident long-term care insurance certification: the Ohsaki Cohort 2006 Study]. *Nihon Koshu Eisei Zasshi*. 2011;58:3–13. doi:10.11236/jph.58.1_3
44. Meguro K, Kurihara Project Team. [The validity of the Basic Checklist in the old-old population: the Kurihara Project]. *Jpn J Geriatr Prychiat*. 2012;23:6.
45. Tsubono Y, Tsuji I, Fujita K, et al. Validation of walking questionnaire for population-based prospective studies in Japan: comparison with pedometer. *J Epidemiol*. 2002;12:305–309. doi:10.2188/jea.12.305
46. Wilson RS, Segawa E, Boyle PA, Bennett DA. Influence of late-life cognitive activity on cognitive health. *Neurology*. 2012;78:1123–1129. doi:10.1212/WNL.0b013e31824f8c03
47. Wilson RS, Mendes De Leon CF, Barnes LL, et al. Participation in cognitively stimulating activities and risk of incident Alzheimer disease. *JAMA*. 2002;287:742–748. doi:10.1001/jama.287.6.742
48. Valeri L, VanderWeele TJ. Mediation analysis allowing for exposure-mediator interactions and causal interpretation: theoretical assumptions and implementation with SAS and SPSS macros. *Psychol Methods*. 2013;18:137–150. doi:10.1037/a0031034
49. Hosokawa R, Kondo K, Ito M, et al. The effectiveness of Japan's community centers in facilitating social participation and maintaining the functional capacity of older people. *Res Aging*. 2019;41:315–335. doi:10.1177/0164027518805918