BMJ Open

Social participation and the combination of future disability and mortality among Japanese older people: A prospective cohort study from the Aichi Gerontological Evaluation Study (AGES)

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-030500
Article Type:	Research
Date Submitted by the Author:	17-Mar-2019
Complete List of Authors:	Takahashi, Sei; Fukushima Medical University, Center for Innovative Research for Communities and Clinical Excellence; Kyoto University, Department of Healthcare Epidemiology Ojima, Toshiyuki; Hamamatsu University School of Medicine, Department of Community Health and Preventive Medicine Kondo, Katsunori; Chiba University, Center for Preventive Medical Science Shimizu, Sayaka; Kyoto University, Department of Healthcare Epidemiology Fukuhara, Shunichi; Kyoto University, Department of Healthcare Epidemiology Yamamoto, Yosuke; Kyoto University, Department of Healthcare Epidemiology
Keywords:	successful aging, preventative healthcare, physical function, social capital

Social participation and the combination of future disability and mortality among Japanese older people: A prospective cohort study from the Aichi Gerontological Evaluation Study (AGES)

Sei Takahashi, MD, MPH[a,b], Toshiyuki Ojima, MD, PhD[c], Katsunori Kondo, MD, PhD[d,e], Sayaka Shimizu, MD, PhD[b], Shunichi Fukuhara, MD, DMSc, MACP[a,b,f,g], Yosuke Yamamoto, MD, PhD[b]

[a] Center for Innovative Research for Communities and Clinical Excellence (CIRC^{2}LE), Fukushima Medical University, Fukushima, Japan

[b] Department of Healthcare and Epidemiology, School of Public Health, Kyoto University of Medicine, Kyoto, Japan

[c] Hamamatsu University School of Medicine, Hamamatsu, Japan

[d] Department of Gerontological Evaluation, Center for Gerontology and Social Science, National Center for Geriatrics and Gerontology, Japan

[e] Department of Social Preventive Medical Sciences, Center for Preventive Medical Sciences, Chiba University, Japan

[f] Department of Innovative Research and Education for Clinicians and Trainees (DiRECT), Fukushima Medical University Hospital, Fukushima, Japan

[g] Department of General Medicine, Shirakawa Satellite Teaching and Research (STAR), Fukushima Medical University, Fukushima, Japan

Corresponding author: Yosuke Yamamoto, Department of Healthcare and Epidemiology, School of Public Health, Kyoto University of Medicine, Kyoto 606-8501 Japan

E-mail: yamamoto.yosuke.5n@kyoto-u.ac.jp

Word count (excluding title page, abstract, references, figures and tables): 2,257

ABSTRACT

OBJECTIVES: Our study aimed to examine the longitudinal association between social participation and both disability and death during a long-term, follow-up period.

DESIGN: A prospective-cohort study with 9.4-years follow-up.

SETTING: Six Japanese municipalities.

PARTICIPANTS: 15,313 independent subjects who did not have qualifications for receiving Long Term Care Insurance at baseline based on the data from Aichi Gerontological Evaluation Study (AGES, 2003-). They received a questionnaire to measure social participation and other potential confounders. Social participation was defined as participating in at least one organization from 8 categories.

PRIMARY AND SECONDARY OUTCOME MEASURES: Main outcomes were classified by 3 categories at the end of a 9.4-year observational period: living without a disability, living with a disability, and death. We estimated adjusted odds ratio (AOR) using multinomial logistic regression analyses with adjustment for possible confounders.

RESULTS: The primary analysis included 9,741 subjects. Multinomial logistic regression analysis revealed that social participation was associated with significantly lower risk of a disability (AOR, 0.82; 95% CI, 0.69 to 0.97) or death (AOR, 0.78; 95% CI, 0.70 to 0.88).

CONCLUSIONS: Social participation may be associated with a decreased risk of functional disability and mortality among elderly patients.

Keywords: successful aging; preventative healthcare; physical function; social capital

Strengths and Limitations

- ✓ The present study was based on a large cohort of community dwelling older people which enabled us to accurately measure participant's disability or survival with a median of 9.4 years follow-up and few dropouts.

- ✓ Using the combination of the two outcomes, we showed the prognosis of older people with or without social participation.

- ✓ The limitation of the study was that the cohort questionnaire only performed measurement of social participation at baseline and no measurements were obtained from the same participants during the follow-up periods.

- ✓ Further study will be required to evaluate the association between outcomes and social participation based on the measurement in several points, and then to examine whether an intervention of some social activity may decrease both death and functional disability in older people.

INTRODUCTION

An aging society is a major issue in developed countries as well as in some developing countries. In 2015, the United Nations reported that there were almost 901 million people aged ≥60 years, comprising 12% of the global population.[1] Japan is experiencing the most rapid increase of an older population among all countries, with about 33% its population consisting of people ≥ 60 years.[2] One of major concern of a rapidly aging society is the social burden of older people who need care. In 2015, > 5.6 million people, or 36.2% of people aged ≥ 65, required care within the Japanese healthcare system.[3] To reduce the number of older people who need care, it is essential to prevent diseases such as cerebrovascular disease and dementia.[4] The World Health Organization has proposed the concept of "Healthy Aging," defined as "the process of developing and maintaining the functional ability that enables well-being in older age,"[5] in order to decrease the social burden of vulnerable older people.

Recently, social capital has received increased attention because it may have some potential for preventing functional disability and death. Social participation is a subordinate concept of social capital.[6] People who get involved in social activities such as sport clubs, hobby clubs, and religious organizations have opportunities to meet someone, communicate with others, and share knowledge with members of these organizations. Previous studies showed that social participation among older people is associated with a risk reduction in the need for long-term care (LTC)[7-9] or death.[10-14] However, previous studies have several limitations. For example, in studies that examined the relationship between social participation and disability, patients who died were treated as censored cases or were not described in the results.[7-9] Other studies that investigated the association between social participation and mortality did not analyze functional disability simultaneously with death. For example, one study[12] investigated the relationship between social participation and

cognitive impairment and death, but these two outcomes were analyzed separately instead of in a single model. Both functional disability and death are relevant outcomes for older people. No long-term, follow-up study elucidates the proportion of subjects who develop functional disability or who die based on their degree of social participation.

We conducted a longitudinal, cohort study to investigate the association between social participation and functional disability and death using the Aichi Gerontological Evaluation Study (AGES).

METHODS

Design and Setting

The relationship between social participation and long-term outcome of older people was analyzed based on the Aichi Gerontological Evaluation Study (AGES) longitudinal data.[15] Participants were aged ≥ 65 years and did not have physical or cognitive impairment at baseline. Participants were randomly selected from 6 municipalities (Handa city, Tokoname city, Agui town, Taketoyo town, Minamichita town, and Mihama town) in Aichi prefecture, Japan. If the population of the municipality was ≤ 5,000, all people in the municipality were selected as participants. If the population of the municipality was > 5,000, 5,000 persons were randomly sampled using the resident registration list. Participants answered a self-reported questionnaire by mail, including their health status, social participation, and socioeconomic status in 2003 for baseline survey data; they were followed up until the development of functional decline; eligibility for LTC, or death. More information on AGES is available elsewhere.[15] The Kyoto University Ethics Committee approved this study. The Nihon Fukushi University Ethics Committee originally approved AGES projects. Written informed consent was assumed with voluntary return of the questionnaire.

Study Population

Eligible participants were individuals ≥ 65 years who answered the AGES self-reported questionnaire in 2003. Subjects who had qualifications for receiving long-term care at the beginning of the observational period were excluded. We also excluded those who could not perform activities of daily living (ADL) independently or who did not answer the questionnaire related to social participation.

Social Participation

We divided social participation into 8 types based on a previous study:[8] neighborhood associations/senior citizen clubs/fire-fighting teams (local community), hobby groups (hobby), sports groups or clubs (sports), political organizations or groups (politics), industrial or trade associations (industry), religious organizations or groups (religion), volunteer groups (volunteer), and citizen or consumer groups (citizen). Questions used to measure social participation were based on the Japanese version of General Social Survey (JGSS).[16] Participants answered 'currently participate' or 'do not currently participate' for each type of social participation at baseline. In the primary analysis, subjects were categorized as the non-participation group (no participation in any group) or the social participation group (participation in ≥1 group).

Outcomes

The primary outcome was the incidence of disability or death at the end of 9.4-year observational period. The incidence of disability was defined based on certification of the need for LTC.[17] The need for LTC was determined based on a formal evaluation in accordance with routine criteria that combine a home-visit evaluation with the judgment of the primary doctor.[18] Secondary outcomes were incidence of disability or death at 2 years and 5 years. We derived information on certification of the need for LTC or death from the database provided by the municipalities. Data were also obtained regarding whether subjects

moved out of the area and we excluded subjects who moved out at the end of observation before primary analysis.

Statistical Analysis

We described baseline characteristics using means and standard deviations for continuous variables and percentages for categorical variables. Additionally, we showed the proportion of subjects with each outcome by social participation group (yes or no) as well as by the number of types of social participation. In the primary analysis, we performed multinomial logistic regression analyses with adjustment for possible confounders (age per 5-year increment), gender, smoking, alcohol consumption, living alone, walking time (>30 minutes a day/≤30 minutes a day), annual household income (>3,000,000 yen a year/≤ 3,000,000 yen a year), and number of comorbidities (1/≥2) to examine the relationship between social participation and the development each outcome (the incidence of disability or death) during the 9.4-year follow up. Missing data for all variables were not imputed.

In the secondary analysis, we examined the relationship between each type of social participation and outcomes (disability or death) during the 9.4-year follow up using multinomial logistic regression with adjustment for the same confounders as above. Then, using the model above, we investigated the number of types of social participation and outcomes. Subjects were placed into one of four categories: people with no social participation, 1 type of social participation, 2 types of social participation, and ≥ 3 types of social participation. Further, we conducted multinomial logistic analysis regarding outcomes at 2 years and 5 years with adjustment for the same confounders as above.

Finally, we performed a sensitivity analysis, changing the definition of disability from the development of LTC to the certification of Needed Support using multinomial logistic model with adjustment for the same confounders listed above. Certification for Needed Support indicates ADL and instrumental ADL could be performed mostly

independently, but some daily support was required. The tendency for disability is generally milder than those who need LTC.

All analyses were performed with multiple imputation methods using STATA version 14.2 (Stata Corp., LP, College Station, TX, USA). A *p*-value <0.05 was considered statistically significant.

Patient and public involvement

There was no participant's involvement in establishing the research question, outcome measures including the study design and interpretation. We will disseminate the results through the website and social media.

RESULTS

Baseline Characteristics

Figure 1 shows the flow diagram of the study. Among 15,313 participants, 9,863 participants (73.6%) were in the social participation group. Mean age was 72.5 years in participants with social participation and 72.9 years in those without social participation. The highest proportion of social participation was seen in local community and hobby groups (Supplementary Table S1).

Figure 2 shows the proportion of participants who developed each outcome at 2 years, 5 years, and 9.4 years. At the end of the observation period, in those with social participation, 6,463 participants (67.5%) lived without disability, 839 (8.8%) lived with disability, and 2,275 participants (23.7%) had died.

Primary Analysis

Of 9,741 participants were included in the primary analysis. Multivariable multinomial

logistic regression analysis showed that participants with social participation were significantly less likely to develop disability or die than those without social participation during the 9.4-year follow-up period: adjusted odds ratio (AOR)= 0.82, 95% confidence interval [CI], 0.69-0.97; AOR= 0.78; 95% CI: 0.70-0.88, respectively (Table 1).

Table 1. Association between social participation and the incidence of disability or death at 9.4 years (N = 9,741) AOR（95% CI）

	Survival with disability	Death
	845 (8.7)	2,443 (25.1)
Variable[a]	AOR (95% CI)	AOR (95% CI)
Social participation (yes)	0.82 (0.69-0.97)	0.78 (0.70-0.88)
Age (per 5 years)	2.06 (1.93-2.19)	2.16 (2.06-2.26)
Gender (men)	0.80 (0.67-0.95)	1.98 (1.76-2.24)
Family (living alone)	1.03 (0.78-1.31)	0.91 (0.74-1.11)
Education (< 9 years)	0.92 (0.79-1.08)	0.94 (0.85-1.05)
Smoking (yes)	1.50 (1.19-1.88)	1.74 (1.51-2.00)
Alcohol (yes)	1.05 (0.86-1.30)	0.92 (0.81-1.05)
Walking time (< 30 min/day)	0.80 (0.69-0.94)	0.73 (0.66-0.81)
Household income (< 3,000,000 Yen/year)	0.88 (0.75-1.03)	0.96 (0.86-1.07)
1 comorbidity	1.39 (1.10-1.75)	1.28 (1.10-1.50)
≥ 2 comorbidities	1.59 (1.27-1.98)	1.67 (1.45-1.94)

Note: AOR, adjusted odds ratio; CI, confidence interval.

[a]Adjusted for age, gender, living alone, education, smoking, alcohol, walking time, household income and number of comorbidities

Secondary Analysis

Multinomial logistic regression analysis was performed to examine the relationship between each type of social participation and outcomes. Results showed that participants in local community, hobby groups, and sports groups were significantly less likely to die than those without participation in these groups (AOR= 0.85, 95% CI: 0.73-0.99; AOR= 0.71, 95% CI: 0.60-0.85; and AOR= 0.65, 95% CI: 0.52-0.80, respectively. On the other hand, participants in religious organizations or groups were significantly more likely to develop disability than those without such participation (AOR= 1.33, 95% CI: 1.08-1.65) (Table 2).

Table 2. Association between each type of social participation and the incidence of disability or death at 9.4 years (N = 9,741)

	Survival with disability	Death
	AOR (95% CI)	AOR (95% CI)
Social participation group, n (%)[a]	845 (8.7)	2,443(25.1)
Local community 5,692 (58.4)	0.85 (0.73-0.99)	0.84 (0.76-0.93)
Hobby groups 3,101 (31.8)	0.71 (0.60-0.85)	0.70 (0.63-0.79)
Sports groups or clubs 2,067 (21.1)	0.65 (0.52-0.80)	0.64 (0.56-0.73)
Political organizations or groups 820 (8.4)	1.08 (0.82-1.43)	1.04 (0.87-1.25)
Industrial or trade associations 1,040 (10.7)	1.02 (0.79-1.33)	1.01 (0.86-1.20)

Religious organizations or groups 1,114 (11.4)	1.33 (1.08-1.65)	1.15 (0.98-1.34)
Volunteer groups 1,052 (10.8)	0.86 (0.66-1.13)	0.98 (0.83-1.17)
Citizen or consumer groups 456 (4.7)	1.03 (0.71-1.48)	1.15 (0.90-1.46)

Note: AOR, adjusted odds ratio; CI, confidence interval.

[a]Adjusted age, gender, living alone or not, educational attainment, smoking, alcohol, walking time, household income and the number of comorbidity.

With regard to the association between the numbers of types of social participation and the incidence of disability or death at the 9.4-year follow-up, results showed that subjects with 2 types of social participation were less likely to die than those without participation (AOR= 0.76, 95% CI: 0.65-0.88). Participants with ≥3 types of social participation were less likely to develop disability or die than subjects without participation (AOR= 0.67, 95% CI: 0.53-0.85; AOR= 0.67, 95% CI: 0.57-0.78), respectively (Table 3).

Table 3. Relationship between the number of types of social participation and the incidence of disability and death at 9.4-years (N = 9,741)

	Survival with disability	Death
No. of subjects, n (%)	AOR（95% CI）	AOR（95% CI）
Social participation group, n (%)[a]	845(8.7)	2,443(25.1)
1 social group, 2,994 (30.7)	0.86 (0.71-1.05)	0.88 (0.77-1.01)
2 social groups, 2,192 (22.5)	0.92 (0.74-1.13)	0.76 (0.65-0.88)

≥ 3 groups, 2,174 (22.3)	0.67 (0.53-0.85)	0.67 (0.57-0.78)

Note: AOR, adjusted odds ratio; CI, confidence interval.

[a]Adjusted age, gender, living alone or not, educational attainment, smoking, alcohol, household income, walking time and the number of comorbidity.

After 2 years of follow up, participants with social participation were significantly less likely to develop disability than those without participation (AOR= 0.45; 95% CI: 0.32-0.64). After 5 years of follow-up, participants with social participation were less likely to develop disability and death than those without social participation (AOR= 0.68; 95% CI: 0.54-0.86; AOR= 0.83; 95% CI: 0.71-0.96), respectively (Supplementary Table S2).

Sensitivity Analysis

In sensitivity analysis, results indicated subjects with participation in social groups were less likely to develop mild disability than those without participation (AOR= 0.93; 95% CI: 0.81-1.07), but results were not statistically significant. (Supporting information Table S3)

DISCUSSION

This is the first study that examined the association between social participation and the loss of healthy aging during 9.4 years of follow up. At the end of follow-up, subjects with social participation were more likely to remain functionally independent than subjects without social participation. Results were significant in all of the primary outcomes in multinomial logistic regression analysis adjusted for confounding factors. Furthermore, a relationship was seen between the number of types of social participation and each outcome, suggesting the

robustness of the results. Secondary analyses based on the 2-year and 5-year follow up were similar to the results of primary analysis. The sensitivity analysis was performed by examining results from living with and without mild impairment and using outcome criteria as a person's history of Certification of Needed Support. Findings were similar to those of the main analysis.

Results of the present study support previous studies, but these studies evaluated only one outcome (disability or death) and did not take both outcomes into account in a single model.[7–11, 13, 14] The present study was the first study that focused on the combination of 2 relevant outcomes in the same model.

Mechanisms regarding why and how social participation affect healthy aging and death are not yet known, but growing evidences suggest that social participation stimulates a participant's body and brain and helps subjects remain highly functional.[10, 19] Another study suggested that participants with social participation may have easier access to social support.[20] With regard to biomedical mechanisms, social participation may suppress inflammatory markers such as interleukin-6 or C-reactive protein and reduce physical stress.[21] Further studies are needed to reveal the underlying mechanisms regarding the relationship between social participation and healthy aging.

The strength of the present study was that it is the first study to find that social participation may reduce both functional decline and death. It is also worthwhile to describe the proportions of each outcome in this long-term study. By using outcomes that include the presence or absence of healthy aging, we were able to show the prognosis in detail after a long-term observation of older people. Moreover, the AGES cohort is a relatively large-scale study. The proportion of participants lost to follow up was low (3.4%) even after 9.4 years.

However, there are several limitations to this study. First, measurement of social participation was only performed at baseline. No measurements were obtained during the

follow-up periods. Second, social participation is a subset of social capital as described by Putnam.[6] It has been measured in various ways as an indicator that measures the quality of the social network. The questions in this study were designed to measure only the presence or absence of social participation. Third, there was no information about dementia or cerebrovascular disease in this study, which are 2 of the main causes of death among elderly patients.[22] Fourth, this study used data taken from a single area; thus generalizability of results to other areas or countries cannot be assumed. Finally, the present study is observational, so we could not adjust for the effect of unknown confounding factors in the association between social participation and outcomes or prove a causal effect between social participation and outcomes.

In conclusion, this study indicated that social participation may not only reduce the risk for death, but also reduce the risk for developing disability. Living with disability in the midst of the super-aging society not only impairs the individual quality of life, but also places an additional burden on society. Further study is needed to examine whether an intervention that encourages social participation may reduce death and functional disability among elderly subjects.

ACKNOWLEDGMENTS

The authors thank all staff members in each study area and in the central office for their painstaking efforts in conducting the baseline survey and follow up. We would like to express our deepest gratitude to everyone who participated in the survey.

COMPETING INTERESTS

The authors have no conflicts.

FUNDING

This work was supported by JSPS KAKENHI Grant Number JP18390200 and Health Labour Sciences Research Grant, Comprehensive Research on Aging and Health (H22-Choju-Shitei-008) from the Japanese Ministry of Health, Labour and Welfare.

DATA SHARING STATEMENT

Data are from the JAGES study. All enquiries are to be addressed at the data management committee via e-mail: dataadmin.ml@jages.net. All JAGES datasets have ethical or legal restrictions for public deposition due to inclusion of sensitive information from the human participants. Following the regulation of local governments which cooperated on our survey, the JAGES data management committee has imposed the restrictions upon the data.

AUTHOR CONTRIBUTIONS

ST, YY: study design and conduct. ST: data analysis, statistical analyses, writing the manuscript. YY: primary responsibility for final content. All authors: interpretation of

findings, critical review of manuscript, comments, approval of final manuscript.

SPONSOR'S ROLE: The grant sponsors had no role in the design, methods, subject recruitment, data collection, analysis, or preparation of paper.

REFERENCES

1 United Nations. World Population Prospects (online). Available at: https://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf. Accessed November 17, 2017.

2 Statistics of Japan. List of Statistical Tables (online). Available at: http://www.e-stat.go.jp/SG1/estat/GL38020103.do?_toGL38020103_&tclassID=0000001077438&cycleCode=0&requestSender=estat. Accessed December 5, 2017.

3 Cabinet Office Government of Japan. Annual Report on the Aging Society: 2016 (Summary) (online). Available at: http://www8.cao.go.jp/kourei/whitepaper/w-2016/html/gaiyou/index.html. Accessed March 7, 2017.

4 Ministry of Health, Labour and Welfare. Evaluations of the Second Phase of Healthy Japan 21 (online). Available at: http://www.mhlw.go.jp/stf/seisakunitsuite/bunya/kenkou_iryou/kenkou/kenkounippon21.html. Accessed March 7, 2017.

5 World Report on Ageing and Health (online). Available at: https://apps.who.int/iris/bitstream/handle/10665/186463/9789240694811_eng.pdf?sequence=1 Accessed November 14, 2017.

6 Putnam RD. Bowling alone: America's declining social capital. *J Democr* 1995;6:65–78.

7 Kanamori S, Kai Y, Kondo K, et al. Participation in sports organizations and the prevention of functional disability in older Japanese: the AGES Cohort Study. *PLoS One* 2012;7:e51061.

8 Kanamori S, Kai Y, Aida J, et al. Social participation and the prevention of functional disability in older Japanese: the JAGES cohort study. *PLoS One* 2014;9:e99638.

9 Murata C, Saito T, Tsuji T, et al. A 10-year follow-up study of social ties and functional health among the old: the AGES project. *Int J Environ Res Public Health* 2017;14:pii:E717.

10 Aida J, Kondo K, Hirai H, et al. Assessing the association between all-cause mortality and multiple aspects of individual social capital among the older Japanese. *BMC Public Health* 2011;11:499.

11 Kawachi I, Colditz GA, Ascherio A, et al. A prospective study of social networks in relation to total mortality and cardiovascular disease in men in the USA. *J Epidemiol Community Health* 1996;50:245–51.

12 Hsu HC. Does social participation by the elderly reduce mortality and cognitive impairment? *Aging Ment Health* 2007;11:699–707.

13 Glass TA, de Leon CM, Marottoli RA, et al. Population based study of social and productive activities as predictors of survival among elderly Americans. *BMJ* 1999;319:478–83.

14 Väänänen A, Murray M, Koskinen A, et al. Engagement in cultural activities and cause-specific mortality: prospective cohort study. *Prev Med* 2009;49:142–7.

15 Nishi A, Kondo K, Hirai H, et al. Cohort profile: the AGES 2003 cohort study in Aichi, Japan. *J Epidemiol* 2011;21:151–7.

16 Iwai N. Japanese General Social Surveys (JGSS) and measurements of family and gender attitudes: Results of the 1st Preliminary Survey. *Kazoku Syakaigaku Kenkyu* 2001;12:261–70 (in Japanese).

17 Healthy Life Expectancy Calculation Guidelines (online). Available at: http://life.umin.jp/hle/Guidelines_tentative.pdf. Accessed March 7, 2017.

18 Tsutsui T, Muramatsu N. Care-needs certification in the long-term care insurance system of Japan. *J Am Geriatr Soc* 2005;53:522–7.

19 Erickson KI, Voss MW, Prakash RS, et al. Exercise training increases size of hippocampus and improves memory. *Proc Natl Acad Sci U S A* 2011;108:3017–22.

20 Zhang W, Chen M. Psychological distress of older Chinese: exploring the roles of activities, social support, and subjective social status. *J Cross Cult Gerontol* 2014;29:37–51.

21 Glei DA, Goldman N, Ryff CD, et al. Social relationships and inflammatory markers: an analysis of Taiwan and the U.S. *Soc Sci Med* 2012;74:1891–9.

22 Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare. Graphical Review of Japanese Household (online). Available at: http://www.mhlw.go.jp/toukei/list/dl/20-21-h25.pdf. Accessed March 7, 2017.

FIGURE LEGENDS

Figure 1. Flow diagram of the study.

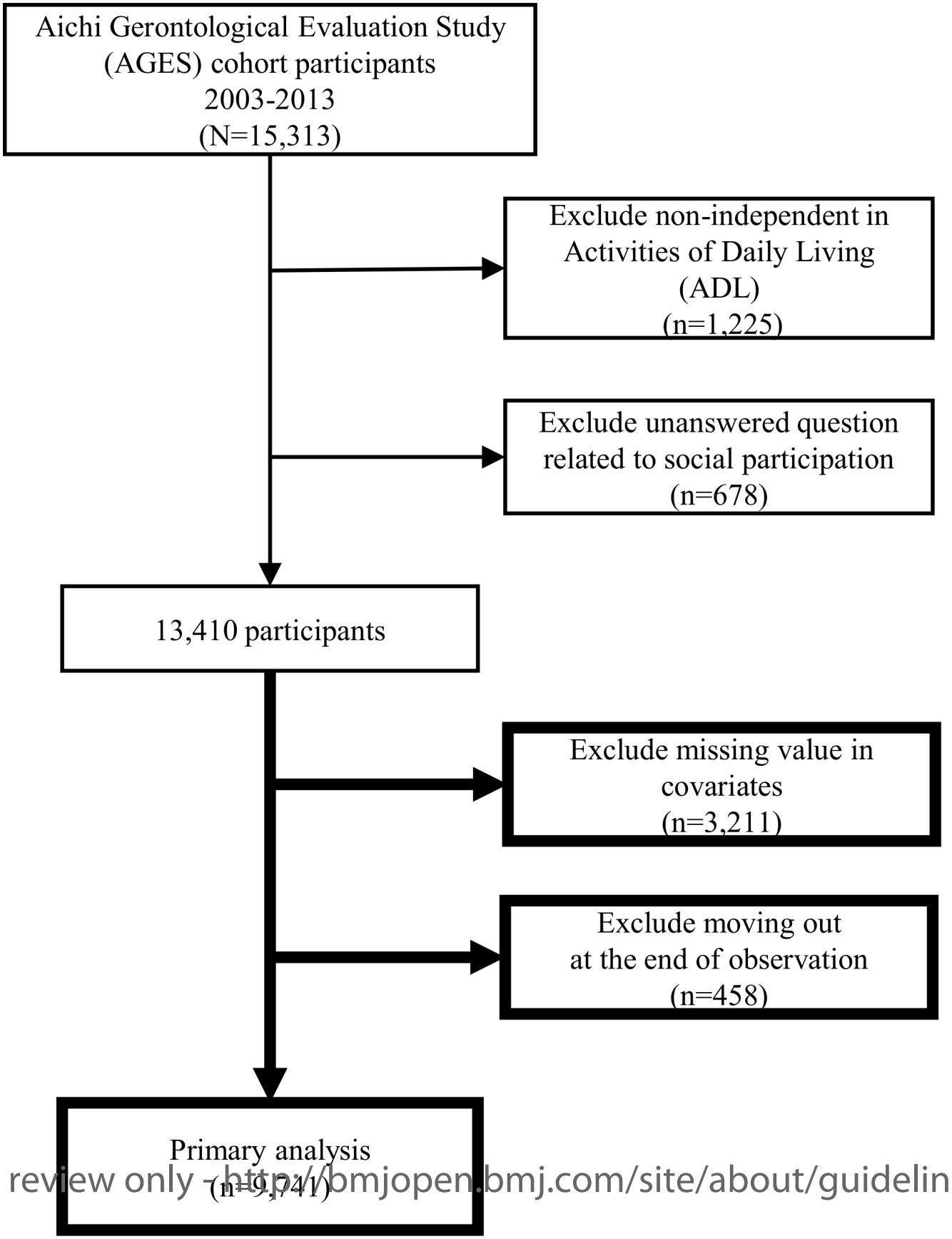
Figure 2. Incidence of disability and death at 2 years, 5 years, and 9.4 years.

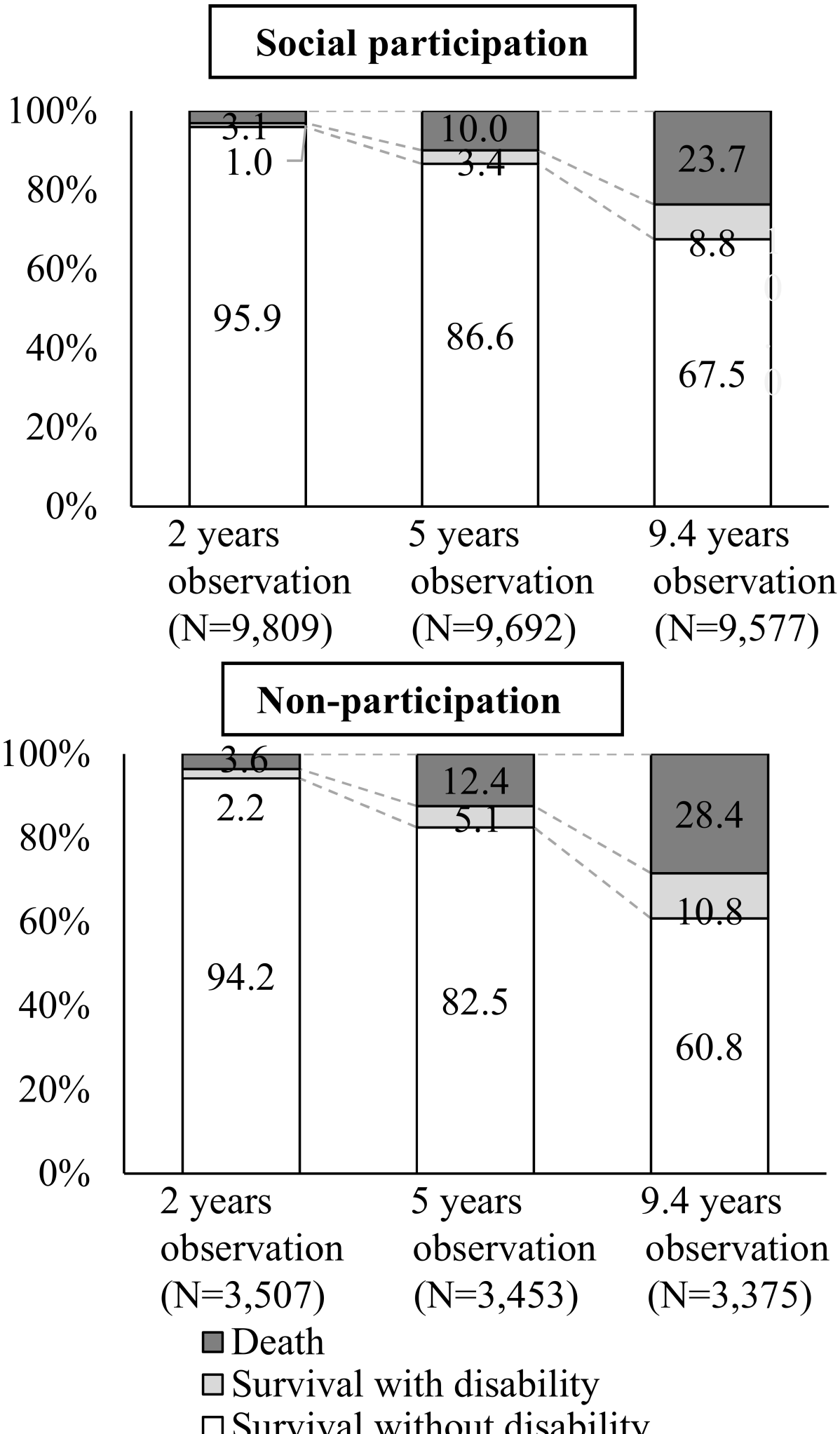
SUPPLEMENTAL INFORMATION

Supplementary Table S1. Baseline characteristics

Supplementary Table S2. Association between social participation and the incidence of disability and death at 2 and 5 years

Supplementary Table S3. Association between social participation and the incidence of disability and death at 9.4 years, where disability was defined as the incidence of Certification of Needed Support




Social participation
100%
80%
60%
40%
20%
0%
3.1
1.0
95.9
10.0
3.4
86.6
23.7
8.8
67.5
2 years observation (N=9,809)
5 years observation (N=9,692)
9.4 years observation (N=9,577)
Non-participation
3.6
2.2
94.2
12.4
5.1
82.5
28.4
10.8
60.8
2 years observation (N=3,507)
5 years observation (N=3,453)
9.4 years observation (N=3,375)
Death
Survival with disability
Survival without disability

Supplementary Table S1. Baseline characteristics

		Social participation	Non-participation	Total
N (%)		9,863 (73.6)	3,547 (26.5)	13,140
Age, y	Average ± Standard deviation	72.5±5.7	72.9±6.3	72.6±5.8
Gender (%)	Men	4,902 (49.7)	1,696 (47.8)	6,598 (49.2)
Social participation (%)	Local community	7,613 (77.2)	-	7,613 (56.8)
	Hobby	4,045 (41.0)	-	4,045 (30.2)
	Sports	2,671 (27.1)	-	2,671 (19.9)
	Politics	1,029 (10.4)	-	1,029 (7.7)
	Industry	1,298 (13.2)	-	1,298 (9.7)
	Religion	1,544 (15.7)	-	1,544 (11.5)
	Volunteer	1,330 (13.5)	-	1,330 (9.9)
	Citizen	623 (6.3)	-	623 (4.7)
Family status	Living alone	936 (9.5)	374 (10.5)	1,310 (9.8)
	Missing	0 (0.0)	0 (0.0)	0 (0.0)
Educational attainment	≥ 9 years	4,291 (43.5)	1,185 (33.4)	5,476 (40.8)
	Missing	77 (0.8)	46 (1.3)	123 (0.9)
Smoking	Current smoker	1,190 (12.1)	511 (14.4)	1,701 (12.7)
	Missing	291 (3.0)	171 (4.8)	462 (3.5)
Alcohol	Current drinker	2,161 (21.9)	638 (18.0)	2,799 (20.9)
	Missing	129 (1.3)	71 (2.0)	200 (1.5)
Walking time	≥ 30 min/day	5,952 (60.4)	1,904 (53.7)	7,856 (58.6)
	Missing	890 (9.0)	403 (11.4)	1,293 (9.6)
Household income	≥ 3,000,000 yen/year	5,389 (54.6)	1,488 (42.0)	6,877 (51.3)
	Missing	1,404 (14.2)	666 (18.8)	2,070 (15.4)
Numbers of comorbidity	1	3,415 (34.6)	1,239 (34.9)	4,654 (34.7)
	≥ 2	4,516 (45.8)	1,614 (45.5)	6,130 (45.7)
	Missing	0 (0.0)	0 (0.0)	0 (0.0)

Supplementary Table S2. Association between social participation and the incidence of disability and death at 2 and 5 years

Follow-up period	Survival with disability	Death
2 years (n = 10,019)		
No. of subjects, n (%)[a]	136.4 (1.4)	333 (3.3)
Social participation (yes)		
AOR (95% CI)	0.45 (0.32-0.64)	0.92 (0.71-1.18)
5 years (n = 9,888)		
No. of subjects, n (%)[a]	346 (3.5)	1,050 (10.6)
Social participation, yes		
AOR (95% CI)	0.68 (0.54-0.86)	0.83 (0.71-0.96)

Note: AOR, adjusted odds ratio; CI, confidence interval.

[a]Adjusted for age, gender, living alone, education, smoking, alcohol, household income, walking time, and number of comorbidities

Supplementary Table S3. Association between social participation and the incidence of disability and death at 9.4 years, where disability was defined as the incidence of Certification of Needed Support

	Survival with disability	Death
	1,263 (13.0)	1,758 (18.1)
Variable[a]	AOR (95% CI)	AOR (95% CI)
Social participation (yes)	0.93 (0.81-1.07)	0.78 (0.69-0.89)
Age (per 5 years)	2.36 (2.23-2.50)	2.45 (2.45-2.72)
Gender (men)	0.66 (0.57-0.75)	1.78 (1.57-2.01)
Family (living alone)	1.04 (0.85-1.28)	0.92 (0.74-1.13)
Education (< 9 years)	0.99 (0.88-1.12)	0.95 (0.85-1.06)
Smoking (yes)	1.45 (1.20-1.74)	1.82 (1.58-2.11)
Alcohol (yes)	0.97 (0.82-1.14)	0.91 (0.80-1.04)
Walking time (< 30 min/day)	0.85 (0.75-0.96)	0.72 (0.64-0.80)
Household income (< 3,000,000 yen/year)	0.81(0.71-0.92)	0.92 (0.82-1.03)
1 comorbidity	1.44 (1.21-1.73)	1.32 (1.13-1.55)
≥ 2 comorbidities	1.97 (1.66-2.34)	1.87 (1.61-2.17)

Note: AOR, adjusted odds ratio; CI, confidence interval.

[a]Adjusted for age, gender, living alone, education, smoking, alcohol, walking time, household income and number of comorbidities

Reporting checklist for cohort study.

Based on the STROBE cohort guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cohort reporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

		Reporting Item	Page Number
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2

Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	#3	State specific objectives, including any prespecified hypotheses	4-5
Study design	#4	Present key elements of study design early in the paper	5
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up.	6
	#6b	For matched studies, give matching criteria and number of exposed and unexposed	-
Variables	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	5
Bias	#9	Describe any efforts to address potential sources of bias	13
Study size	#10	Explain how the study size was arrived at	8
Quantitative	#11	Explain how quantitative variables were handled in the	7

variables		analyses. If applicable, describe which groupings were chosen, and why	
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	7
	#12b	Describe any methods used to examine subgroups and interactions	7
	#12c	Explain how missing data were addressed	7
	#12d	If applicable, explain how loss to follow-up was addressed	-
	#12e	Describe any sensitivity analyses	7
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	8
	#13b	Give reasons for non-participation at each stage	8
	#13c	Consider use of a flow diagram	8
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	8
	#14b	Indicate number of participants with missing data for each variable of interest	8

	#14c	Summarise follow-up time (eg, average and total amount)	8
Outcome data	#15	Report numbers of outcome events or summary measures over time. Give information separately for exposed and unexposed groups if applicable.	8
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	8-9
	#16b	Report category boundaries when continuous variables were categorized	8
	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	9
Key results	#18	Summarise key results with reference to study objectives	12
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	13
Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	13
Generalisability	#21	Discuss the generalisability (external validity) of the study	13

		results	
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

BMJ Open

Social participation and the combination of future needs for long term care and mortality among older Japanese people: A prospective cohort study from the Aichi Gerontological Evaluation Study (AGES)

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-030500.R1
Article Type:	Original research
Date Submitted by the Author:	24-Jul-2019
Complete List of Authors:	Takahashi, Sei; Fukushima Medical University, Center for Innovative Research for Communities and Clinical Excellence; Kyoto University, Department of Healthcare Epidemiology Ojima, Toshiyuki; Hamamatsu University School of Medicine, Department of Community Health and Preventive Medicine Kondo, Katsunori; Chiba University, Department of Social Preventive Medical Sciences, Center for Preventive Medical Sciences; National Center for Geriatrics and Gerontology, Department of Gerontological Evaluation, Center for Gerontology and Social Science Shimizu, Sayaka; Kyoto University, Department of Healthcare Epidemiology Fukuhara, Shunichi; Kyoto University, Department of Healthcare Epidemiology Yamamoto, Yosuke; Kyoto University, Department of Healthcare epidemiology
Primary Subject Heading:	Geriatric medicine
Secondary Subject Heading:	Epidemiology
Keywords:	successful aging, preventative healthcare, physical function, social capital

Social participation and the combination of future needs for long term care and mortality among older Japanese people: A prospective cohort study from the Aichi Gerontological Evaluation Study (AGES)

Sei Takahashi, MD, MPH[a,b], Toshiyuki Ojima, MD, PhD[c], Katsunori Kondo, MD, PhD[d,e], Sayaka Shimizu, MD, PhD[b], Shunichi Fukuhara, MD, DMSc, MACP[a,b,f,g], Yosuke Yamamoto, MD, PhD[b]

[a] Center for Innovative Research for Communities and Clinical Excellence (CIRC^{2}LE), Fukushima Medical University, Fukushima, Japan

[b] Department of Healthcare and Epidemiology, School of Public Health, Kyoto University of Medicine, Kyoto, Japan

[c] Hamamatsu University School of Medicine, Hamamatsu, Japan

[d] Department of Gerontological Evaluation, Center for Gerontology and Social Science, National Center for Geriatrics and Gerontology, Japan

[e] Department of Social Preventive Medical Sciences, Center for Preventive Medical Sciences, Chiba University, Japan

[f] Department of Innovative Research and Education for Clinicians and Trainees (DiRECT), Fukushima Medical University Hospital, Fukushima, Japan

[g] Department of General Medicine, Shirakawa Satellite Teaching and Research (STAR), Fukushima Medical University, Fukushima, Japan

Corresponding author: Yosuke Yamamoto, Department of Healthcare and Epidemiology, School of Public Health, Kyoto University of Medicine, Kyoto 606-8501 Japan

E-mail: yamamoto.yosuke.5n@kyoto-u.ac.jp

Word count (excluding title page, abstract, references, figures, and tables): 2,553

ABSTRACT

OBJECTIVES: Our study aimed to examine the longitudinal association between social participation and both the need for long-term care (LTC) and death during a long-term, follow-up period.

DESIGN: A prospective-cohort study with 9.4 years of follow-up.

SETTING: Six Japanese municipalities.

PARTICIPANTS: The participants were 15,313 people who did not qualify to receive Long Term Care Insurance at a baseline based on the data from the Aichi Gerontological Evaluation Study (AGES, 2003–). They received a questionnaire to measure social participation and other potential confounders. Social participation was defined as participating in at least one organization from eight categories.

PRIMARY AND SECONDARY OUTCOME MEASURES: The primary outcomes were classified into three categories at the end of the 9.4-year observational period: living without the need for LTC, living with the need for LTC, and death. We estimated the adjusted odds ratio (AOR) using multinomial logistic regression analyses with adjustment for possible confounders.

RESULTS: The primary analysis included 9,741 participants. Multinomial logistic regression analysis revealed that social participation was associated with a significantly lower risk of the need for LTC (AOR, 0.82; 95% CI, 0.69 to 0.97) or death (AOR, 0.78; 95% CI, 0.70 to 0.88).

CONCLUSIONS: Social participation may be associated with a decreased risk of the need for LTC and mortality among elderly patients.

Keywords: successful aging; preventative healthcare; physical function; social capital

Strengths and Limitations of this Study

- ✓ The present study was based on a large cohort of community-dwelling older people which enabled us to accurately measure participants' need to receive care or survival with a median follow-up of 9.4 years and few dropouts.

- ✓ Using the combination of the two outcomes, we showed the prognosis of older people with or without social participation.

- ✓ The limitation of the study was that the cohort questionnaire only measured social participation at a baseline, and no measurements were obtained from the same participants during the follow-up periods.

- ✓ Further study will be required to evaluate the association between outcomes and social participation based on the measurement in several points, and then to examine whether an intervention of some social activity may decrease both death and functional disability in older people.

INTRODUCTION

An aging society is a major issue in developed countries as well as in some developing countries. In 2015, the United Nations reported that there were almost 901 million people over the age of 60, comprising 12% of the global population.[1] Japan is experiencing the most rapid increase of an older population among all countries, with about 33% of its population consisting of people over the age of 60.[2] One of major concerns of a rapidly aging society is the social burden of older people who need care. In 2015, more than 5.6 million people, or 36.2% of people aged 65 and over, required care within the Japanese healthcare system.[3] These populational transitions would have enormous influence on our access to quality health and social care and the opportunities that aging brings. The World Health Organization has proposed the concept of "Healthy Aging," defined as "the process of developing and maintaining the functional ability that enables well-being in older age,"[4] for all people to live long and healthy lives.

Recently, social capital has received increased attention because it may have some potential for preventing functional disability and death. Social participation has been defined by Putnam,[5] Berkman,[6] and various researchers. Particularly, it was defined by the WHO as a component of the social determinant of health and it contains various kinds of forms as follows: informing people with balanced, objective information; consulting, whereby the affected community provides feedback; involving or working directly with communities; collaborating by partnering with affected communities in each aspect of the decision making process, including the development of alternatives and the identification of solutions; and empowering people by ensuring that communities retain ultimate control over the key decisions that affect their wellbeing.[7] Previous studies have shown that social participation among older people is associated with a reduced risk of the need for long-term care (LTC)[8-10] or death.[11-15] However, previous studies have several limitations. For

example, in studies that examined the relationship between social participation and disability, patients who died were treated as censored cases or were not described in the results.[8-10] Other studies that investigated the association between social participation and mortality did not simultaneously analyze functional disability and death. For example, one study[13] investigated the relationship between social participation and cognitive impairment and death, but these two outcomes were analyzed separately instead of in a single model. Both functional disability and death are relevant outcomes for older people. No long-term, follow-up study has thus far elucidated the proportion of participants who need LTC or who die based on their degree of social participation.

We conducted a longitudinal cohort study to investigate the association between social participation and the need for LTC and death using the Aichi Gerontological Evaluation Study (AGES).

METHODS

Design and Setting

The relationship between social participation and the long-term outcomes of older people was analyzed based on the Aichi Gerontological Evaluation Study (AGES) longitudinal data.[16] Participants were aged 65 and older and did not have physical or cognitive impairments at the baseline. Participants were randomly selected from six municipalities (Handa city, Tokoname city, Agui town, Taketoyo town, Minamichita town, and Mihama town) in Aichi prefecture, Japan. If the population of the municipality was less than or equal to 5,000, all people in the municipality were selected as participants. If the population of the municipality was greater than 5,000, 5,000 persons were randomly sampled using the resident registration list. Participants answered a self-reported questionnaire by mail, including questions about their health status, social participation, and socioeconomic status in 2003 for the baseline survey

data; they were followed up until the development of functional decline, eligibility for LTC, or death. More information on AGES is available elsewhere.[16] The Kyoto University Ethics Committee approved this study (the number of approval: R0425). The Nihon Fukushi University Ethics Committee originally approved the AGES projects (the number of approval: 13-14). Written informed consent was assumed with the voluntary return of the questionnaires.

Study Population

Eligible participants were individuals over the age of 65 who answered the AGES self-reported questionnaire in 2003. Participants who qualified to receive long-term care at the beginning of the observational period were excluded. We also excluded those who could not independently perform activities of daily living (ADL) or who did not answer the questionnaire related to social participation.

Social Participation

We divided social participation into eight types based on a previous study:[9] neighborhood associations/senior citizen clubs/fire-fighting teams (local community), hobby groups (hobby), sports groups or clubs (sports), political organizations or groups (politics), industrial or trade associations (industry), religious organizations or groups (religion), volunteer groups (volunteer), and citizen or consumer groups (citizen). Questions used to measure social participation were based on the Japanese version of the General Social Survey (JGSS).[17] Participants answered “currently participate” or “do not currently participate” for each type of social participation at the baseline. In the primary analysis, participants were categorized as the non-participation group (no participation in any group) or the social participation group (participation in at least one group).

Outcomes

The primary outcome was the need for LTC or death at the end of the 9.4-year observational

period. The need for LTC was determined based on a formal evaluation in accordance with routine criteria that combine a home-visit evaluation with the judgment of the primary doctor.[18] Applicants or their family members essentially apply to their municipality for certification of LTC when the applicants find themselves in need of some care support or users' family members recognize that they need to introduce care support in the user's life. Secondary outcomes were the incidence of disability or death at two and five years. We derived information on the certification of the need for LTC or death from the database provided by the municipalities. Data were also obtained regarding whether participants moved out of the area; we excluded participants who moved out at the end of observation before primary analysis.

Statistical Analysis

We described baseline characteristics using means and standard deviations for continuous variables and percentages for categorical variables. Additionally, we showed the proportion of participants with each outcome by social participation group (yes or no), as well as by the number of types of social participation. In the primary analysis, we performed multinomial logistic regression analyses with adjustment for possible confounders (age per five-year increment), gender, living alone, educational attainment (more than nine years), smoking, alcohol consumption, walking time (more than thirty minutes a day), annual household income (more than 3,000,000 yen a year), and number of comorbidities (one or more than two) to examine the relationship between social participation and the development of each outcome (the incidence of disability or death) during the 9.4-year follow-up. Missing data for all variables were not imputed.

In the secondary analysis, we examined the relationship between each type of social participation and outcomes (disability or death) during the 9.4-year follow-up using multinomial logistic regression with adjustment for the same confounders as above. Using the

model above, we then investigated the number of types of social participation and outcomes. Participants were placed into one of four categories: people with no social participation, one type of social participation, two types of social participation, and at least three or more types of social participation. Further, we conducted multinomial logistic analysis regarding outcomes at two and five years with adjustment for the same confounders as above.

Finally, we performed a sensitivity analysis, changing the definition of disability from the development of LTC to the certification of Needed Support using a multinomial logistic model with adjustment for the same confounders listed above. Certification for Needed Support indicates that ADL and instrumental ADL could mostly be performed independently, but some daily support was required. The tendency for disability is generally milder than those who need LTC.

All analyses were performed using STATA version 14.2 (Stata Corp., LP, College Station, TX, USA). A *p*-value <0.05 was considered statistically significant.

Patient and public involvement

There was no participant involvement in establishing the research question, outcome measures including the study design, and interpretation. We will disseminate the results through the website and social media.

RESULTS

Baseline Characteristics

Figure 1 shows the flow diagram of the study. Among 15,313 participants, 9,863 (73.6%) were in the social participation group. The mean age was 72.5 years in participants with social participation and 72.9 years in those without social participation. The highest proportion of social participation was seen in local community and hobby groups. Around

10% of the social participation group participated in political groups, industrial groups, religious groups, and volunteer groups. The proportion of higher educational attainment and higher household income was about 10% higher in the social participation group. Thus, participants with social participation were likely to present higher educational attainment and higher household income than those without (Supplementary Table S1). Figure 2 shows the proportion of participants who developed each outcome at 2, 5, and 9.4 years. At the end of the observational period, in those with social participation, 6,463 participants (67.5%) lived without disability, 839 (8.8%) lived with disability, and 2,275 participants (23.7%) had died.

Primary Analysis

The primary analysis included 9,741 participants. Multivariable multinomial logistic regression analysis showed that participants with social participation were significantly less likely to develop disability or die than those without social participation during the 9.4-year follow-up period: adjusted odds ratio (AOR)= 0.82, 95% confidence interval [CI], 0.69-0.97; AOR= 0.78; 95% CI: 0.70-0.88, respectively (Table 1).

Table 1. Multinomial logistic regression analysis: Association between social participation and the need for LTC or death at 9.4 years (N = 9,741) AOR(95% CI) - Reference category: No disability

	Survival with the need for LTC	Death
	845 (8.7)	2,443 (25.1)
Variable	AOR (95% CI)	AOR (95% CI)
Social participation (yes)	0.82 (0.69-0.97)*	0.78 (0.70-0.88)**

Age (per 5 years)	2.06 (1.93-2.19)**	2.16 (2.06-2.26)**
Gender (men)	0.80 (0.67-0.95)*	1.98 (1.76-2.24)**
Family (living alone)	1.03 (0.78-1.31)	0.91 (0.74-1.11)
Educational attainment (more than 9 years)	0.92 (0.79-1.08)	0.94 (0.85-1.05)
Smoking (yes)	1.50 (1.19-1.88)**	1.74 (1.51-2.00)**
Alcohol (yes)	1.05 (0.86-1.30)	0.92 (0.81-1.05)
Walking time (more than 30 min/day)	0.80 (0.69-0.94)**	0.73 (0.66-0.81)**
Household income (more than 3,000,000 Yen/year)	0.88 (0.75-1.03)	0.96 (0.86-1.07)
1 comorbidity	1.39 (1.10-1.75)**	1.28 (1.10-1.50)**
2 or more comorbidities	1.59 (1.27-1.98)**	1.67 (1.45-1.94)**

*: $p<0.05$, **: $p<0.01$.

Note: LTC, long-term care; AOR, adjusted odds ratio; CI, confidence interval.

Secondary Analysis

Multinomial logistic regression analysis was performed to examine the relationship between each type of social participation and the outcomes. Results showed that participants in local community, hobby, and sports groups were significantly less likely to die than those without participation in these groups (AOR= 0.85, 95% CI: 0.73-0.99; AOR= 0.71, 95% CI: 0.60-0.85; and AOR= 0.65, 95% CI: 0.52-0.80, respectively). On the other hand, participants in religious organizations or groups were significantly more likely to develop disability than those without such participation (AOR= 1.33, 95% CI: 1.08-1.65) (Table 2).

Table 2. Multinomial logistic regression analysis: Association between each type of social participation and the incidence of disability or death at 9.4 years (N = 9,741) AOR (95% CI) - Reference category: No disability

	Survival with the need for LTC AOR (95% CI)	Death AOR (95% CI)
Social participation group, n (%)[a]	845 (8.7)	2,443(25.1)
Local community 5,692 (58.4)	0.85 (0.73-0.99)*	0.84 (0.76-0.93)*
Hobby groups 3,101 (31.8)	0.71 (0.60-0.85)*	0.70 (0.63-0.79)*
Sports groups or clubs 2,067 (21.1)	0.65 (0.52-0.80)*	0.64 (0.56-0.73)*
Political organizations or groups 820 (8.4)	1.08 (0.82-1.43)	1.04 (0.87-1.25)
Industrial or trade associations 1,040 (10.7)	1.02 (0.79-1.33)	1.01 (0.86-1.20)
Religious organizations or groups 1,114 (11.4)	1.33 (1.08-1.65)*	1.15 (0.98-1.34)
Volunteer groups 1,052 (10.8)	0.86 (0.66-1.13)	0.98 (0.83-1.17)
Citizen or consumer groups 456 (4.7)	1.03 (0.71-1.48)	1.15 (0.90-1.46)

*: $p<0.05$, **: $p<0.01$.

Note: LTC, long-term care; AOR, adjusted odds ratio; CI, confidence interval.

[a]Adjusted age, gender, living alone or not, educational attainment, smoking, alcohol, walking time, household income, and the number of comorbidity.

With regard to the association between the number of types of social participation and the incidence of disability or death at the 9.4-year follow-up, results showed that participants

with two types of social participation were less likely to die than those without participation (AOR= 0.76, 95% CI: 0.65-0.88). Participants with three or more types of social participation were less likely to develop disability or die than participants without participation (AOR= 0.67, 95% CI: 0.53-0.85; AOR= 0.67, 95% CI: 0.57-0.78, respectively) (Table 3).

Table 3. Multinomial logistic regression analysis: Relationship between the number of types of social participation and the need for LTC and death at 9.4-years (N = 9,741) AOR (95% CI) - Reference category: No disability

	Survival with the need for LTC	Death
No. of participants, n (%)	AOR（95% CI）	AOR（95% CI）
Social participation group, n (%)[a]	845(8.7)	2,443(25.1)
1 social group, 2,994 (30.7)	0.86 (0.71-1.05)	0.88 (0.77-1.01)
2 social groups, 2,192 (22.5)	0.92 (0.74-1.13)	0.76 (0.65-0.88)**
≥ 3 groups, 2,174 (22.3)	0.67 (0.53-0.85)**	0.67 (0.57-0.78)**

*: p<0.05, **: p<0.01.

Note: LTC, long-term care; AOR, adjusted odds ratio; CI, confidence interval

[a]Adjusted age, gender, living alone or not, educational attainment, smoking, alcohol, household income, walking time, and the number of comorbidity.

After two years of follow-up, participants with social participation were significantly less likely to develop disability than those without participation (AOR= 0.45; 95% CI: 0.32-0.64).

After five years of follow-up, participants with social participation were less likely to develop disability and die than those without social participation (AOR= 0.68; 95% CI: 0.54-0.86; AOR= 0.83; 95% CI: 0.71-0.96, respectively) (Supplementary Table S2).

Sensitivity Analysis

In sensitivity analysis, the results indicated that participants with participation in social groups were less likely to develop mild disability than those without participation (AOR= 0.93; 95% CI: 0.81-1.07); however, the results were not statistically significant (Supplementary Table S3).

DISCUSSION

This study showed the association between social participation and the need for LTC or death during 9.4 years of follow-up. At the end of the follow-up period, participants with social participation were more likely to remain functionally independent than participants without social participation. The results were significant in all of the primary outcomes in the multinomial logistic regression analysis adjusted for confounding factors. Furthermore, a relationship was seen between the number of types of social participation and each outcome, suggesting the robustness of the results. Secondary analyses based on the two- and five-year follow-up were similar to the results of the primary analysis. Sensitivity analysis was performed by examining the results from living with and without mild impairment and using the outcome criteria as a person's history of Certification of Needed Support. The findings were similar to those of the main analysis.

The results of the present study support previous studies, but these studies evaluated only one outcome (disability or death) and did not take both outcomes into account in a single

model.[8-12, 14, 15] The present study is the first study to focus on the combination of two relevant outcomes in the same model.

The mechanisms regarding why and how social participation affects healthy aging and death are not yet known, but growing evidence suggests that social participation stimulates a participant's body and brain and helps participants remain highly functional.[11, 19] Another study suggested that participants with social participation may have easier access to social support.[20] With regard to biomedical mechanisms, social participation may suppress inflammatory markers such as interleukin-6 or C-reactive protein and reduce physical stress.[21] Further studies are needed to reveal the underlying mechanisms regarding the relationship between social participation and healthy aging, i.e., what kind of form or content of participation may sustain the health of older people or how many frequencies of social participation may maintain a participant's health or their health-related behaviors. To analyze the relationship between a participant's behaviors and health-related outcomes will be beneficial for not only the individual's health, but also for policy makers who are trying to promote social participation.

The strength of the present study is that it is the first study to use composite outcomes of both the need for care support and death to examine the relationship between social participation and the elderly's relevant outcomes. This study found that social participation may reduce both the need for care support and death. It is also worthwhile to describe the proportions of each outcome in this long-term study. By using outcomes that include the presence or absence of healthy aging, we were able to show the prognosis in detail after the long-term observation of older people. Moreover, the AGES cohort is a relatively large-scale study. The proportion of participants lost to follow-up was low (3.4%), even after 9.4 years.

However, there are several limitations to this study. First, the measurement of social participation was only performed at the baseline. No measurements were obtained during the

follow-up periods. Second, social participation is a subset of social capital as described by Putnam.[7] It has been measured in various ways as an indicator that measures the quality of the social network. The questions in this study were designed to measure only the presence or absence of social participation. We could not use the information regarding the intensity and duration of social participation. Third, there was no information about dementia or cerebrovascular disease in this study, which are two of the main causes of death among elderly patients.[22] Fourth, this study used data taken from a single area; thus, the generalizability of results to other areas or countries cannot be assumed. Finally, the present study is observational; thus, we could not adjust for the effect of unknown confounding factors in the association between social participation and outcomes, or prove a causal effect between social participation and outcomes.

In conclusion, this study indicated that social participation may not only reduce the risk of death, but also reduce the risk of developing a disability. Living with disability in the midst of a super-aging society not only impairs the quality of life of the individual, but also places an additional burden on society. Further research is needed to examine whether an intervention that encourages social participation may reduce death and functional disability among elderly people.

ACKNOWLEDGMENTS

The authors thank all staff members in each study area and in the central office for their painstaking efforts in conducting the baseline survey and follow-up. We would also like to

express our deepest gratitude to everyone who participated in the survey.

COMPETING INTERESTS

The authors have no conflicts.

FUNDING

This work was supported by JSPS KAKENHI Grant Number JP18390200 and Health Labour Sciences Research Grant, Comprehensive Research on Aging and Health (H22-Choju-Shitei-008) from the Japanese Ministry of Health, Labour, and Welfare.

DATA SHARING STATEMENT

Data are from the JAGES study. All enquiries are to be addressed to the data management committee via e-mail: dataadmin.ml@jages.net. All JAGES datasets have ethical or legal restrictions for public deposition due to the inclusion of sensitive information from human participants. Following the regulation of local governments which cooperated in our survey, the JAGES data management committee has imposed these restrictions on the data.

AUTHOR CONTRIBUTIONS

ST and TO conceived the idea. ST, YY, SS and SF contributed to the study design. TO and KK contributed to defining data variables and acquisition of data. ST and YY performed statistical analysis, interpreted the data and drafted the manuscript. TO, KK, SS and SF reviewed the manuscript. All authors revised the manuscript for intellectual content and approved final submission.

SPONSOR'S ROLE: The grant sponsors had no role in the design, methods, participant recruitment, data collection, analysis, or preparation of this paper.

REFERENCES

1 United Nations. World Population Prospects (online). Available at: https://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf. Accessed November 17, 2017.

2 Statistics of Japan. List of Statistical Tables (online). Available at: http://www.e-stat.go.jp/SG1/estat/GL38020103.do?_toGL38020103_&tclassID=00000 1077438&cycleCode=0&requestSender=estat. Accessed December 5, 2017.

3 Cabinet Office Government of Japan. Annual Report on the Aging Society: 2016 (Summary) (online). Available at: http://www8.cao.go.jp/kourei/whitepaper/w-2016/html/gaiyou/index.html. Accessed March 7, 2017.

4 WHO | What is Healthy Ageing? WHO. 2018. https://www.who.int/ageing/healthy-ageing/en/. Accessed June 29, 2019.

5 Putnam RD. Bowling alone: America's declining social capital. *J Democr* 1995;6:65–78.

6 Berkman LF. The role of social relations in health promotion. Psychosom Med. 1995;57(3):245-254. http://www.ncbi.nlm.nih.gov/pubmed/7652125. Accessed July 2, 2019.

7 WHO | Social participation. WHO. 2013. https://www.who.int/social_determinants/thecommission/countrywork/within/socialpart icipation/en/. Accessed July 2, 2019.

8 Kanamori S, Kai Y, Kondo K, et al. Participation in sports organizations and the prevention of functional disability in older Japanese: the AGES Cohort Study. *PLoS One* 2012;7:e51061.

9 Kanamori S, Kai Y, Aida J, et al. Social participation and the prevention of functional

disability in older Japanese: the JAGES cohort study. *PLoS One* 2014;9:e99638.

10 Murata C, Saito T, Tsuji T, et al. A 10-year follow-up study of social ties and functional health among the old: the AGES project. *Int J Environ Res Public Health* 2017;14:pii:E717.

11 Aida J, Kondo K, Hirai H, et al. Assessing the association between all-cause mortality and multiple aspects of individual social capital among the older Japanese. *BMC Public Health* 2011;11:499.

12 Kawachi I, Colditz GA, Ascherio A, et al. A prospective study of social networks in relation to total mortality and cardiovascular disease in men in the USA. *J Epidemiol Community Health* 1996;50:245–51.

13 Hsu HC. Does social participation by the elderly reduce mortality and cognitive impairment? *Aging Ment Health* 2007;11:699–707.

14 Glass TA, de Leon CM, Marottoli RA, et al. Population based study of social and productive activities as predictors of survival among elderly Americans. *BMJ* 1999;319:478–83.

15 Väänänen A, Murray M, Koskinen A, et al. Engagement in cultural activities and cause-specific mortality: prospective cohort study. *Prev Med* 2009;49:142–7.

16 Nishi A, Kondo K, Hirai H, et al. Cohort profile: the AGES 2003 cohort study in Aichi, Japan. *J Epidemiol* 2011;21:151–7.

17 Iwai N. Japanese General Social Surveys (JGSS) and measurements of family and gender attitudes: Results of the 1st Preliminary Survey. *Kazoku Syakaigaku Kenkyu* 2001;12:261–70 (in Japanese).

18 Tsutsui T, Muramatsu N. Care-needs certification in the long-term care insurance system of Japan. *J Am Geriatr Soc* 2005;53:522–7.

19 Erickson KI, Voss MW, Prakash RS, et al. Exercise training increases size of

hippocampus and improves memory. *Proc Natl Acad Sci U S A* 2011;108:3017–22.

20 Zhang W, Chen M. Psychological distress of older Chinese: exploring the roles of activities, social support, and subjective social status. *J Cross Cult Gerontol* 2014;29:37–51.

21 Glei DA, Goldman N, Ryff CD, et al. Social relationships and inflammatory markers: an analysis of Taiwan and the U.S. *Soc Sci Med* 2012;74:1891–9.

22 Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare. Graphical Review of Japanese Household (online). Available at: http://www.mhlw.go.jp/toukei/list/dl/20-21-h25.pdf. Accessed March 7, 2017.

FIGURE LEGENDS

Figure 1. Flow diagram of the study.

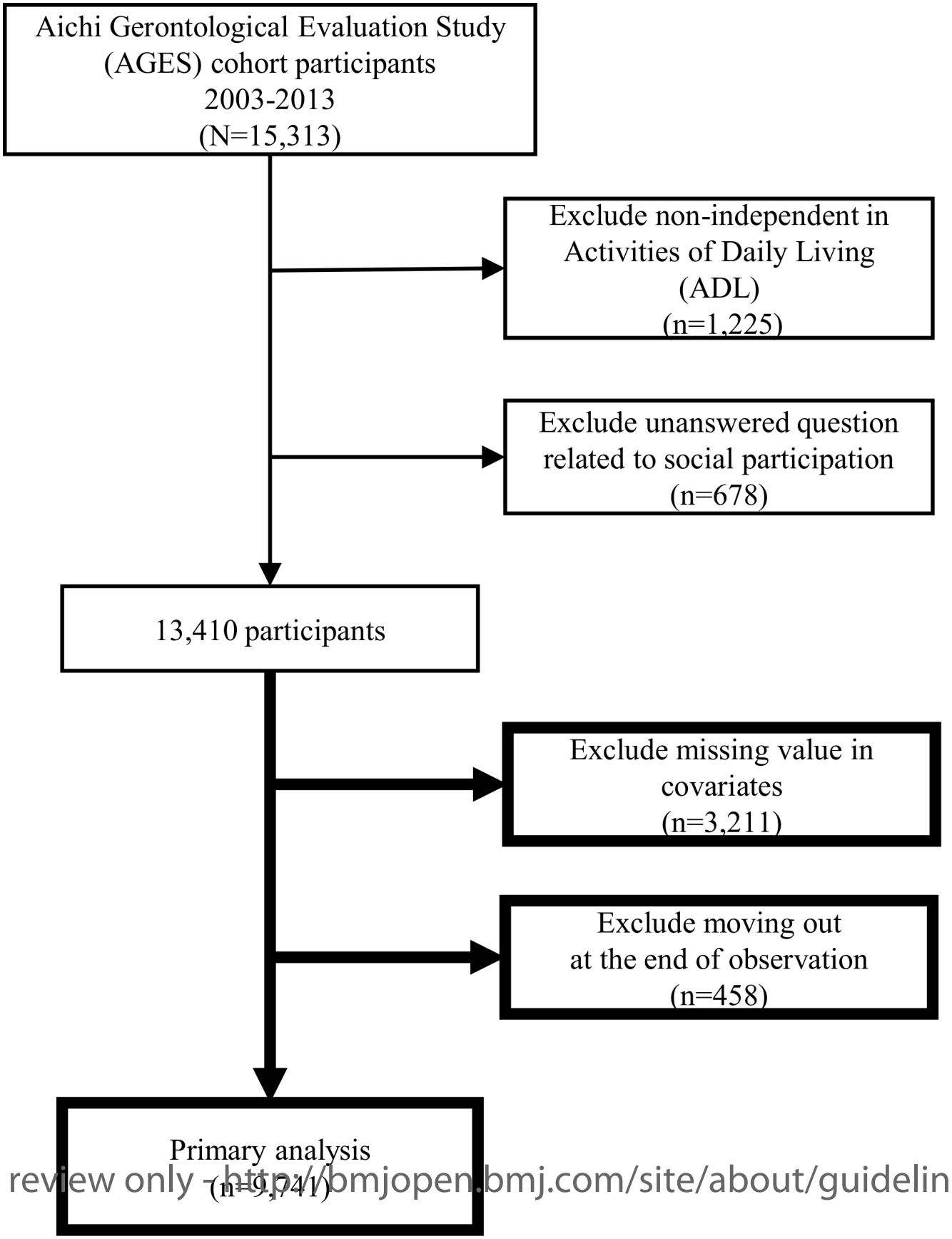
Figure 2. Incidence of disability and death at 2 years, 5 years, and 9.4 years.

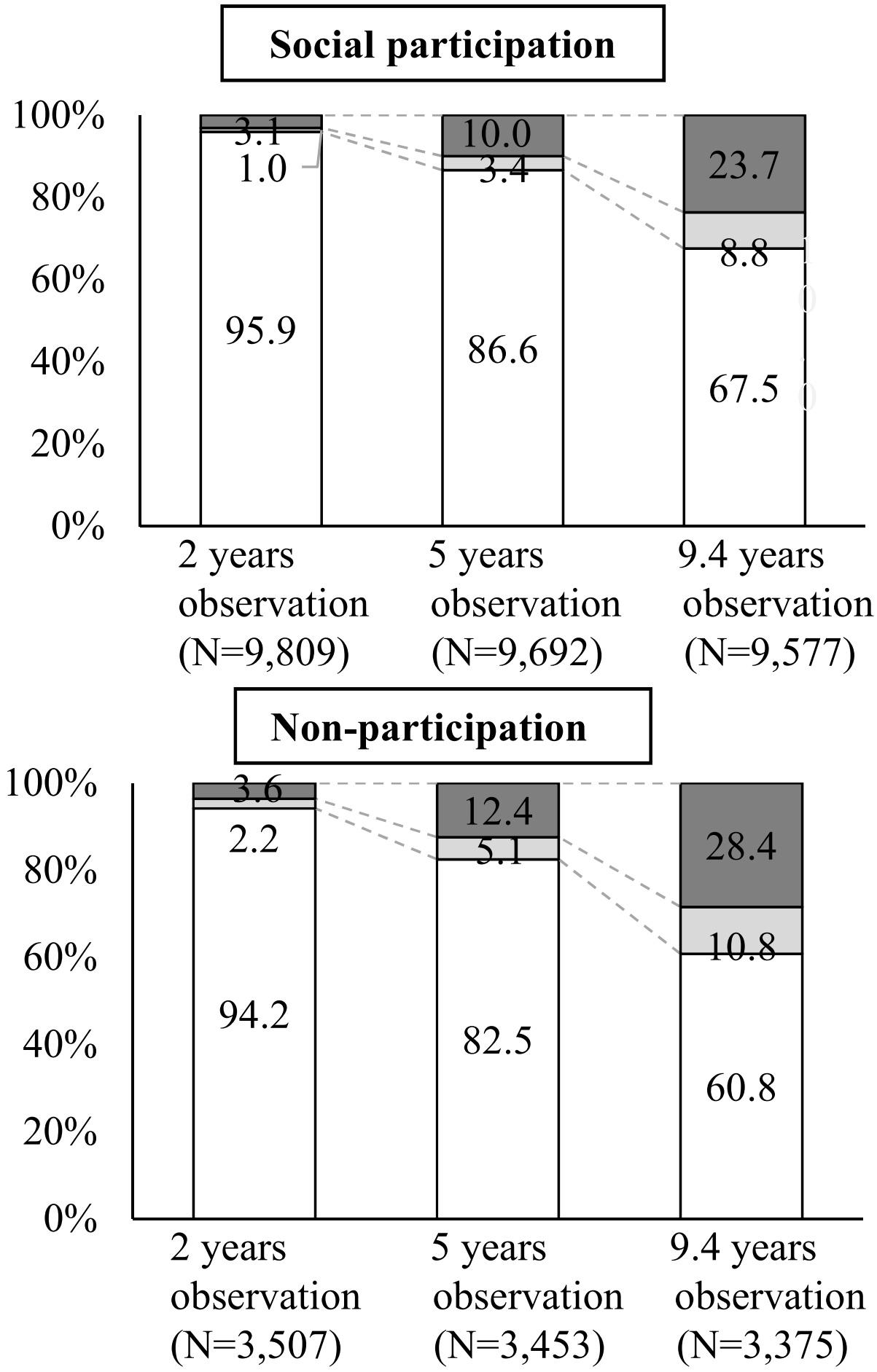
SUPPLEMENTAL INFORMATION

Supplementary Table S1. Baseline characteristics

Supplementary Table S2. Multinomial logistic regression analysis: Association between social participation and the incidence of the need for LTC and death at two and five years - Reference category: No disability

Supplementary Table S3. Multinomial logistic regression analysis: Association between social participation and the incidence of the Certification of Needed Support and death at 9.4 years (N = 9,741) - Reference category: No disability




Social participation
100%
80%
60%
40%
20%
0%
3.1
1.0
95.9
10.0
3.4
86.6
23.7
8.8
67.5
2 years observation (N=9,809)
5 years observation (N=9,692)
9.4 years observation (N=9,577)
Non-participation
3.6
2.2
94.2
12.4
5.1
82.5
28.4
10.8
60.8
2 years observation (N=3,507)
5 years observation (N=3,453)
9.4 years observation (N=3,375)
Death
Survival with the need for LTC
Survival without disability

Supplementary Table S1. Baseline characteristics

		Social participation	Non-participation	Total
N (%)		9,863 (73.6)	3,547 (26.5)	13,140
Age, y	Average ± Standard deviation	72.5±5.7	72.9±6.3	72.6±5.8
Gender (%)	Men	4,902 (49.7)	1,696 (47.8)	6,598 (49.2)
Social participation (%)	Local community	7,613 (77.2)	-	7,613 (56.8)
	Hobby groups	4,045 (41.0)	-	4,045 (30.2)
	Sports groups or clubs	2,671 (27.1)	-	2,671 (19.9)
	Political organization or groups	1,029 (10.4)	-	1,029 (7.7)
	Industrial or trade associations	1,298 (13.2)	-	1,298 (9.7)
	Religious organizations or groups	1,544 (15.7)	-	1,544 (11.5)
	Volunteer groups	1,330 (13.5)	-	1,330 (9.9)
	Citizen or consumer groups	623 (6.3)	-	623 (4.7)
Family status	Living alone	936 (9.5)	374 (10.5)	1,310 (9.8)
	Missing	0 (0.0)	0 (0.0)	0 (0.0)
Educational attainment	More than 9 years	4,291 (43.5)	1,185 (33.4)	5,476 (40.8)
	Missing	77 (0.8)	46 (1.3)	123 (0.9)
Smoking	Current smoker	1,190 (12.1)	511 (14.4)	1,701 (12.7)
	Missing	291 (3.0)	171 (4.8)	462 (3.5)
Alcohol	Current drinker	2,161 (21.9)	638 (18.0)	2,799 (20.9)
	Missing	129 (1.3)	71 (2.0)	200 (1.5)
Walking time	More than 30 min/day	5,952 (60.4)	1,904 (53.7)	7,856 (58.6)
	Missing	890 (9.0)	403 (11.4)	1,293 (9.6)
Household income	More than 3,000,000 yen/year	5,389 (54.6)	1,488 (42.0)	6,877 (51.3)
	Missing	1,404 (14.2)	666 (18.8)	2,070 (15.4)
Numbers of comorbidity	1	3,415 (34.6)	1,239 (34.9)	4,654 (34.7)
	2 or more	4,516 (45.8)	1,614 (45.5)	6,130 (45.7)
	Missing	0 (0.0)	0 (0.0)	0 (0.0)

Supplementary Table S2. Multinomial logistic regression analysis: Association between social participation and the incidence of the need for LTC and death at two and five years - Reference category: No disability

Follow-up period	Survival with disability	Death
2 years (n = 10,019)		
No. of participants, n (%)	136 (1.4)	333 (3.3)
Social participation (yes)		
AOR (95% CI)[a]	0.45 (0.32-0.64)**	0.92 (0.71-1.18)
5 years (n = 9,888)		
No. of participants, n (%)	346 (3.5)	1,047 (10.6)
Social participation, yes		
AOR (95% CI)[a]	0.68 (0.54-0.86)**	0.83 (0.71-0.96)*

*: $p<0.05$, **: $p<0.01$.

Note: LTC, long-term care; AOR, adjusted odds ratio; CI, confidence interval.

[a]Adjusted for age, gender, living alone, education, smoking, alcohol, household income, walking time, and number of comorbidities

Supplementary Table S3. Multinomial logistic regression analysis: Association between social participation and the incidence of the Certification of Needed Support and death at 9.4 years (N = 9,741) - Reference category: No disability

	Survival with the certification of Needed Support	Death
	1,263 (13.0)	1,758 (18.1)
Variable	AOR (95% CI)	AOR (95% CI)
Social participation (yes)	0.93 (0.81-1.07)	0.78 (0.69-0.89)**
Age (per 5 years)	2.36 (2.23-2.50)**	2.45 (2.45-2.72)**
Gender (men)	0.66 (0.57-0.75)**	1.78 (1.57-2.01)**
Family (living alone)	1.04 (0.85-1.28)	0.92 (0.74-1.13)
Education (more than 9 years)	0.99 (0.88-1.12)	0.95 (0.85-1.06)
Smoking (yes)	1.45 (1.20-1.74)**	1.82 (1.58-2.11)**
Alcohol (yes)	0.97 (0.82-1.14)	0.91 (0.80-1.04)
Walking time (more than 30 min/day)	0.85 (0.75-0.96)*	0.72 (0.64-0.80)**
Household income (more than 3,000,000 yen/year)	0.81(0.71-0.92)**	0.92 (0.82-1.03)
1 comorbidity	1.44 (1.21-1.73)**	1.32 (1.13-1.55)**
2 or more comorbidities	1.97 (1.66-2.34)**	1.87 (1.61-2.17)**

*: $p<0.05$, **: $p<0.01$.

Note: AOR, adjusted odds ratio; CI, confidence interval.

Reporting checklist for cohort study.

Based on the STROBE cohort guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cohort reporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

		Reporting Item	Page Number
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2

Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	#3	State specific objectives, including any prespecified hypotheses	4-5
Study design	#4	Present key elements of study design early in the paper	5
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up.	6
	#6b	For matched studies, give matching criteria and number of exposed and unexposed	-
Variables	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	5-6
Bias	#9	Describe any efforts to address potential sources of bias	13
Study size	#10	Explain how the study size was arrived at	8

Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	7
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	7
	#12b	Describe any methods used to examine subgroups and interactions	7
	#12c	Explain how missing data were addressed	7
	#12d	If applicable, explain how loss to follow-up was addressed	-
	#12e	Describe any sensitivity analyses	7-8
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	8
	#13b	Give reasons for non-participation at each stage	8
	#13c	Consider use of a flow diagram	8
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	8

	#14b	Indicate number of participants with missing data for each variable of interest	8
	#14c	Summarise follow-up time (eg, average and total amount)	8
Outcome data	#15	Report numbers of outcome events or summary measures over time. Give information separately for exposed and unexposed groups if applicable.	8
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9
	#16b	Report category boundaries when continuous variables were categorized	8
	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	10
Key results	#18	Summarise key results with reference to study objectives	13
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	14

Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	13-15
Generalisability	#21	Discuss the generalisability (external validity) of the study results	15
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16

BMJ Open

Social participation and the combination of future needs for long term care and mortality among older Japanese people: A prospective cohort study from the Aichi Gerontological Evaluation Study (AGES)

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-030500.R2
Article Type:	Original research
Date Submitted by the Author:	16-Sep-2019
Complete List of Authors:	Takahashi, Sei; Fukushima Medical University, Center for Innovative Research for Communities and Clinical Excellence; Kyoto University, Department of Healthcare Epidemiology Ojima, Toshiyuki; Hamamatsu University School of Medicine, Department of Community Health and Preventive Medicine Kondo, Katsunori; Chiba University, Department of Social Preventive Medical Sciences, Center for Preventive Medical Sciences; National Center for Geriatrics and Gerontology, Department of Gerontological Evaluation, Center for Gerontology and Social Science Shimizu, Sayaka; Kyoto University, Department of Healthcare Epidemiology Fukuhara, Shunichi; Kyoto University, Department of Healthcare Epidemiology Yamamoto, Yosuke; Kyoto University, Department of Healthcare epidemiology
Primary Subject Heading:	Geriatric medicine
Secondary Subject Heading:	Epidemiology
Keywords:	successful aging, preventative healthcare, physical function, social capital

Social participation and the combination of future needs for long term care and mortality among older Japanese people: A prospective cohort study from the Aichi Gerontological Evaluation Study (AGES)

Sei Takahashi, MD, MPH[a,b], Toshiyuki Ojima, MD, PhD[c], Katsunori Kondo, MD, PhD[d,e], Sayaka Shimizu, MD, PhD[b], Shunichi Fukuhara, MD, DMSc, MACP[a,b,f,g], Yosuke Yamamoto, MD, PhD[b]

[a] Center for Innovative Research for Communities and Clinical Excellence (CIRC^{2}LE), Fukushima Medical University, Fukushima, Japan

[b] Department of Healthcare and Epidemiology, School of Public Health, Kyoto University of Medicine, Kyoto, Japan

[c] Hamamatsu University School of Medicine, Hamamatsu, Japan

[d] Department of Gerontological Evaluation, Center for Gerontology and Social Science, National Center for Geriatrics and Gerontology, Japan

[e] Department of Social Preventive Medical Sciences, Center for Preventive Medical Sciences, Chiba University, Japan

[f] Department of Innovative Research and Education for Clinicians and Trainees (DiRECT), Fukushima Medical University Hospital, Fukushima, Japan

[g] Department of General Medicine, Shirakawa Satellite Teaching and Research (STAR), Fukushima Medical University, Fukushima, Japan

Corresponding author: Yosuke Yamamoto, Department of Healthcare and Epidemiology, School of Public Health, Kyoto University of Medicine, Kyoto 606-8501 Japan

E-mail: yamamoto.yosuke.5n@kyoto-u.ac.jp

Word count (excluding title page, abstract, references, figures, and tables): 2,838

ABSTRACT

OBJECTIVES: Our study aimed to examine the longitudinal association between social participation and both need for long-term care (LTC) and death during a long-term, follow-up period.

DESIGN: A prospective-cohort study with 9.4 years of follow-up.

SETTING: Six Japanese municipalities.

PARTICIPANTS: The participants were 15,313 people who did not qualify to receive Long Term Care Insurance at a baseline based on the data from the Aichi Gerontological Evaluation Study (AGES, 2003–). They received a questionnaire to measure social participation and other potential confounders. Social participation was defined as participating in at least one organisation from eight categories.

PRIMARY AND SECONDARY OUTCOME MEASURES: The primary outcomes were classified into three categories at the end of the 9.4-year observational period: living without need for LTC, living with need for LTC, and death. We estimated the adjusted odds ratio (AOR) using multinomial logistic regression analyses with adjustment for possible confounders.

RESULTS: The primary analysis included 9,741 participants. Multinomial logistic regression analysis revealed that social participation was associated with a significantly lower risk of need for LTC (AOR, 0.82; 95% CI, 0.69 to 0.97) or death (AOR, 0.78; 95% CI, 0.70 to 0.88).

CONCLUSIONS: Social participation may be associated with a decreased risk of need for LTC and mortality among elderly patients.

Keywords: successful ageing; preventative healthcare; physical function; social capital

Strengths and Limitations of this Study

- ✓ The present study was based on a large cohort of community-dwelling older people which enabled us to accurately measure participants' need to receive care or survival with a median follow-up of 9.4 years and few dropouts.

- ✓ Using the combination of the two outcomes, we showed the prognosis of older people with or without social participation.

- ✓ The limitation of the study was that the cohort questionnaire only measured social participation at a baseline, and no measurements were obtained from the same participants during the follow-up periods.

- ✓ Further study will be required to evaluate the association between outcomes and social participation based on the measurement in several points, and then to examine whether an intervention of some social activity may decrease both need for long-term care and death in older people.

INTRODUCTION

An ageing society is a major issue in developed countries as well as in some developing countries. In 2015, the United Nations reported that there were almost 901 million people over the age of 60, comprising 12% of the global population.[1] Japan is experiencing the most rapid increase of an older population among all countries, with about 33% of its population consisting of people over the age of 60.[2] One of the major concerns of a rapidly ageing society is the social burden of older people who need care. In 2015, more than 5.6 million people, or 36.2% of people aged 65 and over, required care within the Japanese healthcare system.[3] These populational transitions would have enormous influence on our access to quality health and social care and the opportunities that ageing bring. The World Health Organization has proposed the concept of 'Healthy Aging', defined as 'the process of developing and maintaining the functional ability that enables well-being in older age',[4] for all people to live long and healthy lives.

Recently, social capital has received increased attention because it may have some potential for preventing functional decline and death. Social participation has been defined by Putnam,[5] Berkman,[6] and various other researchers. It was defined by the WHO as a component of the social determinant of health and it contains various kinds of forms as follows: informing people with balanced, objective information; consulting, whereby the affected community provides feedback; involving or working directly with communities; collaborating by partnering with affected communities in each aspect of the decision making process, including the development of alternatives and the identification of solutions; and empowering people by ensuring that communities retain ultimate control over the key decisions that affect their wellbeing.[7] Previous studies have shown that social participation among older people is associated with a reduced risk of need for long-term care (LTC)[8-11] or death.[12-16] However, previous studies have several limitations. For example, in studies

that examined the relationship between social participation and need for LTC, patients who died were treated as censored cases or were not described in the results.[8-11] Other studies that investigated the association between social participation and mortality did not simultaneously analyse functional disability and death. For example, one study [13] investigated the relationship between social participation and functional decline and death, but these two outcomes were analysed separately instead of in a single model. Both functional disability and death are relevant outcomes for older people. No long-term, follow-up study has thus far elucidated the proportion of participants who need LTC or who die based on their degree of social participation.

We conducted a longitudinal cohort study to investigate the association between social participation and need for LTC and death using the Aichi Gerontological Evaluation Study (AGES).

METHODS

Design and Setting

The relationship between social participation and the long-term outcomes of older people was analysed based on the Aichi Gerontological Evaluation Study (AGES) longitudinal data.[17] Participants were aged 65 and older and did not have physical or cognitive impairments at the baseline. Participants were randomly selected from six municipalities (Handa city, Tokoname city, Agui town, Taketoyo town, Minamichita town, and Mihama town) in Aichi prefecture, Japan. If the population of the municipality was less than or equal to 5,000, all people in the municipality were selected as participants. If the population of the municipality was greater than 5,000, 5,000 persons were randomly sampled using the resident registration list. Participants answered a self-reported questionnaire by mail, including questions about their health status, social participation, and socioeconomic status in 2003 for the baseline survey

data; they were followed up until the development of functional decline, eligibility for LTC, or death. More information on AGES is available elsewhere.[17] The Kyoto University Ethics Committee approved this study (the number of approval: R0425). The Nihon Fukushi University Ethics Committee originally approved the AGES projects (the number of approval: 13-14). Written informed consent was assumed with the voluntary return of the questionnaires.

Study Population

Eligible participants were individuals over the age of 65 who answered the AGES self-reported questionnaire in 2003. Participants who qualified to receive long-term care at the beginning of the observational period were excluded. We also excluded those who could not independently perform activities of daily living (ADL) or who did not answer the questionnaire related to social participation.

Social Participation

We divided social participation into eight types based on a previous study:[9] neighbourhood associations/senior citizen clubs/fire-fighting teams (local community), hobby groups (hobby), sports groups or clubs (sports), political organisations or groups (politics), industrial or trade associations (industry), religious organisations or groups (religion), volunteer groups (volunteer), and citizen or consumer groups (citizen). Questions used to measure social participation were based on the Japanese version of the General Social Survey (JGSS).[18] Participants answered 'currently participate' or 'do not currently participate' for each type of social participation at the baseline. In the primary analysis, participants were categorised as the non-participation group (no participation in any group) or the social participation group (participation in at least one group).

Outcomes

The primary outcome was need for LTC or death at the end of the 9.4-year observational

period. The need for LTC was determined based on a formal evaluation in accordance with routine criteria that combine a home-visit evaluation with the judgment of the primary doctor.[19] Applicants or their family members essentially apply to their municipality for certification of LTC when the applicants find themselves in need of some care support or users' family members recognise that they need to introduce care support in the user's life. When applicants are certified, they would be classified as Needed Support or need for LTC. The applicants with lighter functional decline are classified as Needed Support. The LTC certification is generally considered as the activities of daily life (ADL) that the applicant partially or wholly depends on others for.[20] We also defined the reference category as 'without need for LTC' and the category included those who were not certified or certified as Needed Support. Secondary outcomes were the incidence of need for LTC or death at two and five years. We derived information on the certification of need for LTC or death from the database provided by the municipalities. Data were also obtained regarding whether participants moved out of the area; we excluded participants who moved out at the end of observation before the start of primary analysis.

Statistical Analysis

We described baseline characteristics using means and standard deviations for continuous variables and percentages for categorical variables. Additionally, we showed the proportion of participants with each outcome by social participation group (yes or no), as well as by the number of types of social participation. In the primary analysis, we performed multinomial logistic regression analyses with adjustment for possible confounders (age per five-year increment), gender, living alone, educational attainment (more than nine years), smoking, alcohol consumption, walking time (more than thirty minutes a day), annual household income (more than 3,000,000 yen a year), and number of comorbidities (one or more than two) to examine the relationship between social participation and the development of each

outcome (need for LTC or death) during the 9.4-year follow-up. Missing data for all variables were not imputed.

In the secondary analysis, we examined the relationship between each type of social participation and outcomes (need for LTC or death) during the 9.4-year follow-up using multinomial logistic regression with adjustment for the same confounders as above. Using the model above, we then investigated the number of types of social participation and outcomes. Participants were placed into one of four categories: people with no social participation, one type of social participation, two types of social participation, and at least three or more types of social participation. Further, we conducted multinomial logistic analysis regarding outcomes at two and five years with adjustment for the same confounders as above.

Finally, we performed a sensitivity analysis, changing one of the outcome definitions from the development of LTC to the certification of Needed Support using a multinomial logistic model with adjustment for the same confounders as listed above. Certification for Needed Support indicates that ADL and instrumental ADL could mostly be performed independently, but some daily support was required. The tendency for functional decline is generally milder than those who need LTC.

All analyses were performed using STATA version 14.2 (Stata Corp., LP, College Station, TX, USA). A p-value <0.05 was considered statistically significant.

Patient and public involvement

There was no participant involvement in establishing the research question, outcome measures including the study design, and interpretation. We will disseminate the results through the website and social media.

RESULTS

Baseline Characteristics

Figure 1 shows the flow diagram of the study. Among 15,313 participants, 9,863 (73.6%) were in the social participation group. The mean age was 72.5 years in participants with social participation and 72.9 years in those without social participation. The highest proportion of social participation was seen in local community and hobby groups. Around 10% of the social participation group participated in political groups, industrial groups, religious groups, and volunteer groups. The proportion of higher educational attainment and higher household income was about 10% higher in the social participation group. Thus, participants with social participation were likely to present higher educational attainment and higher household income than those without (Supplementary Table S1). Figure 2 shows the proportion of participants who developed each outcome at 2, 5, and 9.4 years. At the end of the observational period, in those with social participation, 6,463 participants (67.5%) lived without need for LTC, 839 (8.8%) lived with need for LTC, and 2,275 participants (23.7%) had died.

Primary Analysis

The primary analysis included 9,741 participants. Multivariable multinomial logistic regression analysis showed that participants with social participation were significantly less likely to develop need for LTC or die than those without social participation during the 9.4-year follow-up period: adjusted odds ratio (AOR) 0.82, 95% confidence interval [CI], 0.69-0.97; AOR= 0.78; 95% CI: 0.70-0.88, respectively (Table 1).

Table 1. Multinomial logistic regression analysis: Association between social participation and need for LTC or death at 9.4 years (N = 9,741) AOR (95% CI) - Reference category: Without need for LTC and death

Variable	Survival with the need for LTC 845 (8.7) AOR (95% CI)	Death 2,443 (25.1) AOR (95% CI)
Social participation (yes)	0.82 (0.69-0.97)*	0.78 (0.70-0.88)**
Age (per 5 years)	2.06 (1.93-2.19)**	2.16 (2.06-2.26)**
Gender (men)	0.80 (0.67-0.95)*	1.98 (1.76-2.24)**
Family (living alone)	1.03 (0.78-1.31)	0.91 (0.74-1.11)
Educational attainment (more than 9 years)	0.92 (0.79-1.08)	0.94 (0.85-1.05)
Smoking (yes)	1.50 (1.19-1.88)**	1.74 (1.51-2.00)**
Alcohol (yes)	1.05 (0.86-1.30)	0.92 (0.81-1.05)
Walking time (more than 30 min/day)	0.80 (0.69-0.94)**	0.73 (0.66-0.81)**
Household income (more than 3,000,000 Yen/year)	0.88 (0.75-1.03)	0.96 (0.86-1.07)
1 comorbidity	1.39 (1.10-1.75)**	1.28 (1.10-1.50)**
2 or more comorbidities	1.59 (1.27-1.98)**	1.67 (1.45-1.94)**

*: $p<0.05$, **: $p<0.01$.

Note: LTC, long-term care; AOR, adjusted odds ratio; CI, confidence interval.

Secondary Analysis

Multinomial logistic regression analysis was performed to examine the relationship between each type of social participation and the outcomes. The results showed that participants in

local community, hobby, and sports groups were significantly less likely to die than those without participation in these groups (AOR= 0.85, 95% CI: 0.73-0.99; AOR= 0.71, 95% CI: 0.60-0.85; and AOR= 0.65, 95% CI: 0.52-0.80, respectively). On the other hand, participants in religious organisations or groups were significantly more likely to develop need for LTC than those without such participation (AOR= 1.33, 95% CI: 1.08-1.65) (Table 2).

Table 2. Multinomial logistic regression analysis: Association between each type of social participation and the incidence of need for LTC or death at 9.4 years (N = 9,741) AOR (95% CI) - Reference category: Without need for LTC and death

	Survival with need for LTC	Death
	AOR (95% CI)	AOR (95% CI)
Social participation group, n (%)[a]	845 (8.7)	2,443(25.1)
Local community 5,692 (58.4)	0.85 (0.73-0.99)*	0.84 (0.76-0.93)*
Hobby groups 3,101 (31.8)	0.71 (0.60-0.85)*	0.70 (0.63-0.79)*
Sports groups or clubs 2,067 (21.1)	0.65 (0.52-0.80)*	0.64 (0.56-0.73)*
Political organisations or groups 820 (8.4)	1.08 (0.82-1.43)	1.04 (0.87-1.25)
Industrial or trade associations 1,040 (10.7)	1.02 (0.79-1.33)	1.01 (0.86-1.20)
Religious organisations or groups 1,114 (11.4)	1.33 (1.08-1.65)*	1.15 (0.98-1.34)
Volunteer groups 1,052 (10.8)	0.86 (0.66-1.13)	0.98 (0.83-1.17)
Citizen or consumer groups 456 (4.7)	1.03 (0.71-1.48)	1.15 (0.90-1.46)

*: $p<0.05$, **: $p<0.01$.

Note: LTC, long-term care; AOR, adjusted odds ratio; CI, confidence interval.

[a]Adjusted age, gender, living alone or not, educational attainment, smoking, alcohol, walking time, household income, and the number of comorbidities.

With regard to the association between the number of types of social participation and the incidence of need for LTC or death at the 9.4-year follow-up, results showed that participants with two types of social participation were less likely to die than those without participation (AOR= 0.76, 95% CI: 0.65-0.88). Participants with three or more types of social participation were less likely to develop need for LTC or die than participants without participation (AOR= 0.67, 95% CI: 0.53-0.85; AOR= 0.67, 95% CI: 0.57-0.78, respectively) (Table 3).

Table 3. Multinomial logistic regression analysis: Relationship between the number of types of social participation and need for LTC and death at 9.4-years (N = 9,741) AOR (95% CI) - Reference category: Without need for LTC and death

	Survival with need for LTC	Death
No. of participants, n (%)	AOR（95% CI）	AOR（95% CI）
Social participation group, n (%)[a]	845(8.7)	2,443(25.1)
1 social group, 2,994 (30.7)	0.86 (0.71-1.05)	0.88 (0.77-1.01)
2 social groups, 2,192 (22.5)	0.92 (0.74-1.13)	0.76 (0.65-0.88)**
≥ 3 groups, 2,174 (22.3)	0.67 (0.53-0.85)**	0.67 (0.57-0.78)**

*: $p<0.05$, **: $p<0.01$.

Note: LTC, long-term care; AOR, adjusted odds ratio; CI, confidence interval

[a]Adjusted age, gender, living alone or not, educational attainment, smoking, alcohol, household income, walking time, and the number of comorbidities.

After two years of follow-up, participants with social participation were significantly less likely to develop need for LTC than those without participation (AOR= 0.45; 95% CI: 0.32-0.64). After five years of follow-up, participants with social participation were less likely to develop need for LTC and die than those without social participation (AOR= 0.68; 95% CI: 0.54-0.86; AOR= 0.83; 95% CI: 0.71-0.96, respectively) (Supplementary Table S2).

Sensitivity Analysis

In sensitivity analysis, the results indicated that participants with participation in social groups were less likely to develop than those without participation (AOR= 0.93; 95% CI: 0.81-1.07); however, the results were not statistically significant (Supplementary Table S3).

DISCUSSION

This study showed the association between social participation and need for LTC or death during 9.4 years of follow-up. At the end of the follow-up period, participants with social participation were more likely to remain functionally independent than participants without social participation. The results were significant in all of the primary outcomes in the multinomial logistic regression analysis adjusted for confounding factors. Furthermore, a relationship was seen between the number of types of social participation and each outcome, suggesting the robustness of the results. Secondary analyses based on the two- and five-year follow-up were similar to the results of the primary analysis. Sensitivity analysis was

performed by examining the results from living with and without mild impairment and using the outcome criteria as a person's history of Certification of Needed Support. The findings were similar to those of the main analysis.

The results of the present study support previous studies, but these studies evaluated only one outcome (need for LTC or death) [8-11, 12-16] and did not take both outcomes into account in a single model.[14] The present study is the first to focus on the combination of two relevant outcomes in the same model.

We defined and classified social participation from the baseline questionnaire to a binary variable denoting the presence or absence of any social participation and adopted onto the main analysis. Further, we conducted secondary analysis using the original eight-type classification of social participation based on the JGSS questionnaire.[18] The results of the secondary analysis showed that several types of social participation were associated with lower incidences of LTC and mortality. In contrast, several types of social participation were not associated with lower incidences of LTC and mortality. Many authors and the WHO had difficulty clearly and concretely defining social participation [5-7], and our results indicated that specific types of social participation may be effective for long-term care and mortality. From the various perspectives of politics, economics, and other academic fields, we should detect the types of social participation that are more effective for the elderly.

The mechanisms regarding why and how social participation affects healthy ageing and death are not yet known, but growing evidence suggests that social participation stimulates a participant's body and brain and helps participants remain highly functional.[12, 21] Another study suggested that participants with social participation may have easier access to social support.[22] With regard to biomedical mechanisms, social participation may suppress inflammatory markers such as interleukin-6 or C-reactive protein and reduce physical stress.[23] Further studies are needed to reveal the underlying mechanisms regarding

the relationship between social participation and healthy ageing, i.e. what kind of form or content of participation may sustain the health of older people or the frequency of social participation that may maintain a participant's health or their health-related behaviours. To analyse the relationship between a participant's behaviours and health-related outcomes will be beneficial for not only the individual's health, but also for policy makers who are trying to promote social participation.

The strength of the present study is that it is the first study to use composite outcomes of both need for care support and death to examine the relationship between social participation and the elderly's relevant outcomes. This study found that social participation may reduce both need for care support and death. It is also worthwhile to describe the proportions of each outcome in this long-term study. By using outcomes that include the presence or absence of healthy ageing, we were able to show the prognosis in detail after the long-term observation of older people. Moreover, the AGES cohort is a relatively large-scale study. The proportion of participants lost to follow-up was low (3.4%), even after 9.4 years.

However, there are several limitations to this study. First, the measurement of social participation was only performed at the baseline. No measurements were obtained during the follow-up periods. Second, social participation is a subset of social capital as described by Putnam.[5] It has been measured in various ways as an indicator that measures the quality of the social network. The questions in this study were designed to measure only the presence or absence of social participation. We could not use the information regarding the intensity and duration of social participation. Third, there was no information about dementia or cerebrovascular disease in this study, which are two of the main causes of death among elderly patients.[24] Fourth, multinomial logistic analysis may be superior to previous methods to compare the elderly's need for LTC and death without need for LTC, but other methods such as the competing risk regression model may be suggested when we focus

separately on the incidence of LTC. Fifth, this study used data taken from a single area; thus, the generalizability of results to other areas or countries cannot be assumed. Finally, the present study is observational; thus, we could not adjust for the effect of unknown confounding factors in the association between social participation and outcomes, or prove a causal effect between social participation and outcomes.

In conclusion, this study indicated that social participation may not only reduce the risk of death, but also reduce the risk of developing a disability. Living with disability in the midst of a super-ageing society not only impairs the quality of life of the individual, but also places an additional burden on society. Further research is needed to examine whether an intervention that encourages social participation may reduce death and functional disability among elderly people.

ACKNOWLEDGEMENTS

The authors thank all staff members in each study area and in the central office for their painstaking efforts in conducting the baseline survey and follow-up. We would also like to express our deepest gratitude to everyone who participated in the survey.

COMPETING INTERESTS

The authors have no conflicts.

FUNDING

This work was supported by JSPS KAKENHI Grant Number JP18390200 and Health Labour Sciences Research Grant, Comprehensive Research on Aging and Health (H22-Choju-Shitei-008) from the Japanese Ministry of Health, Labour, and Welfare.

DATA SHARING STATEMENT

Data are from the JAGES study. All enquiries are to be addressed to the data management committee via e-mail: dataadmin.ml@jages.net. All JAGES datasets have ethical or legal restrictions for public deposition due to the inclusion of sensitive information from human participants. Following the regulation of local governments that cooperated in our survey, the JAGES data management committee has imposed these restrictions on the data.

AUTHOR CONTRIBUTIONS

ST and TO conceived the idea. ST, YY, SS, and SF contributed to the study design. TO and KK contributed to defining the data variables and the acquisition of the data. ST and YY performed statistical analysis, interpreted the data, and drafted the manuscript. TO, KK, SS, and SF reviewed the manuscript. All authors revised the manuscript for intellectual content and approved the final submission.

SPONSOR'S ROLE: The grant sponsors had no role in the design, methods, participant

recruitment, data collection, analysis, or preparation of this paper.

REFERENCES

1 United Nations. World Population Prospects (online). Available at: https://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf. Accessed November 17, 2017.

2 Statistics of Japan. List of Statistical Tables (online). Available at: http://www.e-stat.go.jp/SG1/estat/GL38020103.do?_toGL38020103_&tclassID=00000 1077438&cycleCode=0&requestSender=estat. Accessed December 5, 2017.

3 Cabinet Office Government of Japan. Annual Report on the Aging Society: 2016 (Summary) (online). Available at: http://www8.cao.go.jp/kourei/whitepaper/w-2016/html/gaiyou/index.html. Accessed March 7, 2017.

4 WHO | What is Healthy Ageing? WHO. 2018. https://www.who.int/ageing/healthy-ageing/en/. Accessed June 29, 2019.

5 Putnam RD. Bowling alone: America's declining social capital. *J Democr* 1995;6:65–78.

6 Berkman LF. The role of social relations in health promotion. Psychosom Med. 1995;57(3):245-254. http://www.ncbi.nlm.nih.gov/pubmed/7652125. Accessed July 2, 2019.

7 WHO | Social participation. WHO. 2013. https://www.who.int/social_determinants/thecommission/countrywork/within/socialpart icipation/en/. Accessed July 2, 2019.

8 Kanamori S, Kai Y, Kondo K, et al. Participation in sports organizations and the prevention of functional disability in older Japanese: the AGES Cohort Study. *PLoS One* 2012;7:e51061.

9 Kanamori S, Kai Y, Aida J, et al. Social participation and the prevention of functional

disability in older Japanese: the JAGES cohort study. *PLoS One* 2014;9:e99638.

10 Murata C, Saito T, Tsuji T, et al. A 10-year follow-up study of social ties and functional health among the old: the AGES project. *Int J Environ Res Public Health* 2017;14:pii:E717.

11 Saito M, Aida J, Kondo N, et al. Reduced long-term care cost by social participation among older Japanese adults: a prospective follow-up study in JAGES. *BMJ Open* 2019;9(3):e024439.

12 Aida J, Kondo K, Hirai H, et al. Assessing the association between all-cause mortality and multiple aspects of individual social capital among the older Japanese. *BMC Public Health* 2011;11:499.

13 Kawachi I, Colditz GA, Ascherio A, et al. A prospective study of social networks in relation to total mortality and cardiovascular disease in men in the USA. *J Epidemiol Community Health* 1996;50:245–51.

14 Hsu HC. Does social participation by the elderly reduce mortality and cognitive impairment? *Aging Ment Health* 2007;11:699–707.

15 Glass TA, de Leon CM, Marottoli RA, et al. Population based study of social and productive activities as predictors of survival among elderly Americans. *BMJ* 1999;319:478–83.

16 Väänänen A, Murray M, Koskinen A, et al. Engagement in cultural activities and cause-specific mortality: prospective cohort study. *Prev Med* 2009;49:142–7.

17 Nishi A, Kondo K, Hirai H, et al. Cohort profile: the AGES 2003 cohort study in Aichi, Japan. *J Epidemiol* 2011;21:151–7.

18 Iwai N. Japanese General Social Surveys (JGSS) and measurements of family and gender attitudes: Results of the 1st Preliminary Survey. *Kazoku Syakaigaku Kenkyu* 2001;12:261–70 (in Japanese).

19 Tsutsui T, Muramatsu N. Care-needs certification in the long-term care insurance system of Japan. *J Am Geriatr Soc* 2005;53:522–7.

20 Matsuda S, Muramatsu K, Hayashida K. Eligibility classification logic of the Japanese Long Term Care Insurance. *Asian Pacific J Dis Manag* 2011;5(3):65-74.

21 Erickson KI, Voss MW, Prakash RS, et al. Exercise training increases size of hippocampus and improves memory. *Proc Natl Acad Sci U S A* 2011;108:3017–22.

22 Zhang W, Chen M. Psychological distress of older Chinese: exploring the roles of activities, social support, and subjective social status. *J Cross Cult Gerontol* 2014;29:37–51.

23 Glei DA, Goldman N, Ryff CD, et al. Social relationships and inflammatory markers: an analysis of Taiwan and the U.S. *Soc Sci Med* 2012;74:1891–9.

24 Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare. Graphical Review of Japanese Household (online). Available at: http://www.mhlw.go.jp/toukei/list/dl/20-21-h25.pdf. Accessed March 7, 2017.

FIGURE LEGENDS

Figure 1. Flow diagram of the study.

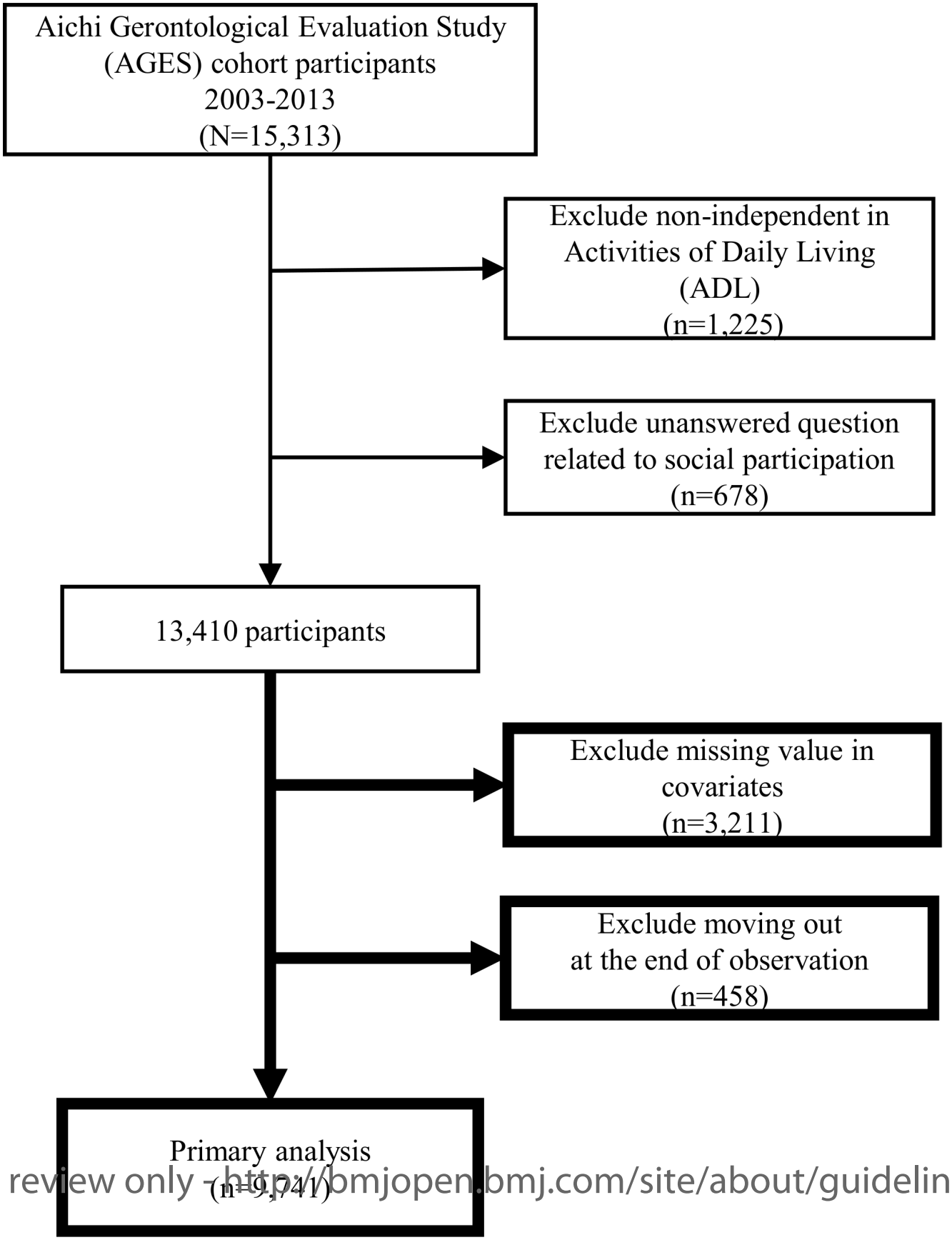
Figure 2. Incidence of need for LTC and death at 2 years, 5 years, and 9.4 years.

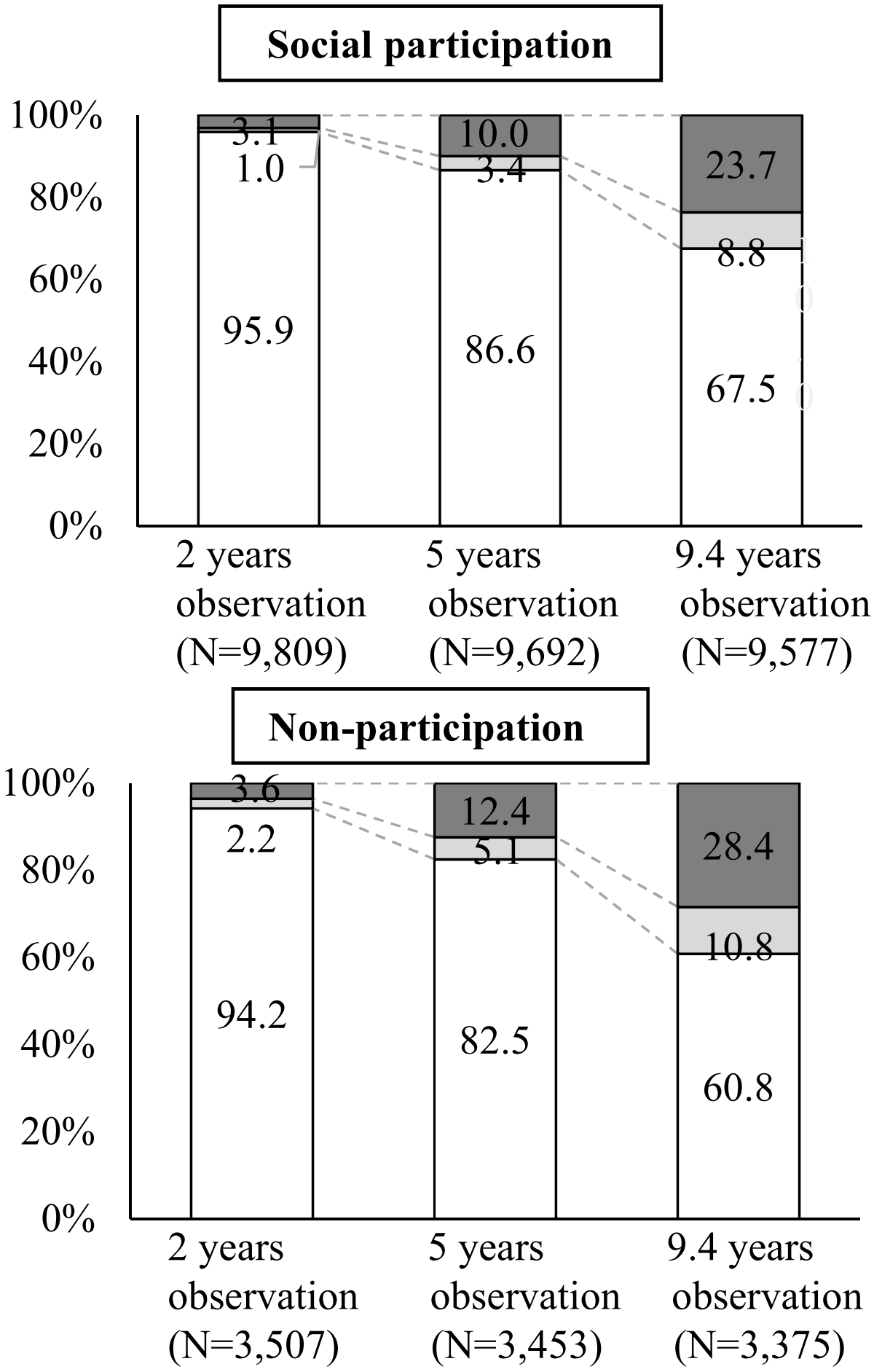
SUPPLEMENTAL INFORMATION

Supplementary Table S1. Baseline characteristics

Supplementary Table S2. Multinomial logistic regression analysis: Association between social participation and the incidence of need for LTC and death at two and five years - Reference category: Without need for LTC and death

Supplementary Table S3. Multinomial logistic regression analysis: Association between social participation and the incidence of the Certification of Needed Support and death at 9.4 years (N = 9,741) - Reference category: Without the certification of Needed Support




Social participation
100%
80%
60%
40%
20%
0%
3.1
1.0
95.9
10.0
3.4
86.6
23.7
8.8
67.5
2 years observation (N=9,809)
5 years observation (N=9,692)
9.4 years observation (N=9,577)
Non-participation
3.6
2.2
94.2
12.4
5.1
82.5
28.4
10.8
60.8
2 years observation (N=3,507)
5 years observation (N=3,453)
9.4 years observation (N=3,375)
Death
Survival with need for LTC
Survival without need for LTC

Supplementary Table S1. Baseline characteristics

		Social participation	Non-participation	Total
N (%)		9,863 (73.6)	3,547 (26.5)	13,140
Age, y	Average ± Standard deviation	72.5±5.7	72.9±6.3	72.6±5.8
Gender (%)	Men	4,902 (49.7)	1,696 (47.8)	6,598 (49.2)
Social participation (%)	Local community	7,613 (77.2)	-	7,613 (56.8)
	Hobby groups	4,045 (41.0)	-	4,045 (30.2)
	Sports groups or clubs	2,671 (27.1)	-	2,671 (19.9)
	Political organization or groups	1,029 (10.4)	-	1,029 (7.7)
	Industrial or trade associations	1,298 (13.2)	-	1,298 (9.7)
	Religious organizations or groups	1,544 (15.7)	-	1,544 (11.5)
	Volunteer groups	1,330 (13.5)	-	1,330 (9.9)
	Citizen or consumer groups	623 (6.3)	-	623 (4.7)
Family status	Living alone	936 (9.5)	374 (10.5)	1,310 (9.8)
	Missing	0 (0.0)	0 (0.0)	0 (0.0)
Educational attainment	More than 9 years	4,291 (43.5)	1,185 (33.4)	5,476 (40.8)
	Missing	77 (0.8)	46 (1.3)	123 (0.9)
Smoking	Current smoker	1,190 (12.1)	511 (14.4)	1,701 (12.7)
	Missing	291 (3.0)	171 (4.8)	462 (3.5)
Alcohol	Current drinker	2,161 (21.9)	638 (18.0)	2,799 (20.9)
	Missing	129 (1.3)	71 (2.0)	200 (1.5)
Walking time	More than 30 min/day	5,952 (60.4)	1,904 (53.7)	7,856 (58.6)
	Missing	890 (9.0)	403 (11.4)	1,293 (9.6)
Household income	More than 3,000,000 yen/year	5,389 (54.6)	1,488 (42.0)	6,877 (51.3)
	Missing	1,404 (14.2)	666 (18.8)	2,070 (15.4)
Numbers of comorbidity	1	3,415 (34.6)	1,239 (34.9)	4,654 (34.7)
	2 or more	4,516 (45.8)	1,614 (45.5)	6,130 (45.7)
	Missing	0 (0.0)	0 (0.0)	0 (0.0)

Supplementary Table S2. Multinomial logistic regression analysis: Association between social participation and the incidence of need for LTC and death at two and five years - Reference category: Without need for LTC

Follow-up period	Survival with need for LTC	Death
2 years (n = 10,019)		
No. of participants, n (%)	136 (1.4)	333 (3.3)
Social participation (yes)		
AOR (95% CI)[a]	0.45 (0.32-0.64)**	0.92 (0.71-1.18)
5 years (n = 9,888)		
No. of participants, n (%)	346 (3.5)	1,047 (10.6)
Social participation, yes		
AOR (95% CI)[a]	0.68 (0.54-0.86)**	0.83 (0.71-0.96)*

*: $p<0.05$, **: $p<0.01$.

Note: LTC, long-term care; AOR, adjusted odds ratio; CI, confidence interval.

[a]Adjusted for age, gender, living alone, education, smoking, alcohol, household income, walking time, and number of comorbidities

Supplementary Table S3. Multinomial logistic regression analysis: Association between social participation and the incidence of the certification of Needed Support and death at 9.4 years (N = 9,741) - Reference category: Without the certification of Needed Support

	Survival with the certification of Needed Support	Death
	1,263 (13.0)	1,758 (18.1)
Variable	AOR (95% CI)	AOR (95% CI)
Social participation (yes)	0.93 (0.81-1.07)	0.78 (0.69-0.89)**
Age (per 5 years)	2.36 (2.23-2.50)**	2.45 (2.45-2.72)**
Gender (men)	0.66 (0.57-0.75)**	1.78 (1.57-2.01)**
Family (living alone)	1.04 (0.85-1.28)	0.92 (0.74-1.13)
Education (more than 9 years)	0.99 (0.88-1.12)	0.95 (0.85-1.06)
Smoking (yes)	1.45 (1.20-1.74)**	1.82 (1.58-2.11)**
Alcohol (yes)	0.97 (0.82-1.14)	0.91 (0.80-1.04)
Walking time (more than 30 min/day)	0.85 (0.75-0.96)*	0.72 (0.64-0.80)**
Household income (more than 3,000,000 yen/year)	0.81(0.71-0.92)**	0.92 (0.82-1.03)
1 comorbidity	1.44 (1.21-1.73)**	1.32 (1.13-1.55)**
2 or more comorbidities	1.97 (1.66-2.34)**	1.87 (1.61-2.17)**

*: $p<0.05$, **: $p<0.01$.

Note: AOR, adjusted odds ratio; CI, confidence interval.

Reporting checklist for cohort study.

Based on the STROBE cohort guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cohort reporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

		Reporting Item	Page Number
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2

Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	#3	State specific objectives, including any prespecified hypotheses	4-5
Study design	#4	Present key elements of study design early in the paper	5
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up.	6
	#6b	For matched studies, give matching criteria and number of exposed and unexposed	-
Variables	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	5-6
Bias	#9	Describe any efforts to address potential sources of bias	13
Study size	#10	Explain how the study size was arrived at	8

Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	7-8
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	7-8
	#12b	Describe any methods used to examine subgroups and interactions	7-8
	#12c	Explain how missing data were addressed	7-8
	#12d	If applicable, explain how loss to follow-up was addressed	-
	#12e	Describe any sensitivity analyses	7-8
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	9
	#13b	Give reasons for non-participation at each stage	9
	#13c	Consider use of a flow diagram	9
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	9

	#14b	Indicate number of participants with missing data for each variable of interest	8
	#14c	Summarise follow-up time (eg, average and total amount)	9
Outcome data	#15	Report numbers of outcome events or summary measures over time. Give information separately for exposed and unexposed groups if applicable.	8
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9
	#16b	Report category boundaries when continuous variables were categorized	7-8
	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	10-13
Key results	#18	Summarise key results with reference to study objectives	13-14
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	15

Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	13-15
Generalisability	#21	Discuss the generalisability (external validity) of the study results	16
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	16-17

BMJ Open

Social participation and the combination of future needs for long-term care and mortality among older Japanese people: A prospective cohort study from the Aichi Gerontological Evaluation Study (AGES)

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2019-030500.R3
Article Type:	Original research
Date Submitted by the Author:	10-Oct-2019
Complete List of Authors:	Takahashi, Sei; Fukushima Medical University, Center for Innovative Research for Communities and Clinical Excellence; Kyoto University, Department of Healthcare Epidemiology Ojima, Toshiyuki; Hamamatsu University School of Medicine, Department of Community Health and Preventive Medicine Kondo, Katsunori; Chiba University, Department of Social Preventive Medical Sciences, Center for Preventive Medical Sciences; National Center for Geriatrics and Gerontology, Department of Gerontological Evaluation, Center for Gerontology and Social Science Shimizu, Sayaka; Kyoto University, Department of Healthcare Epidemiology Fukuhara, Shunichi; Kyoto University, Department of Healthcare Epidemiology Yamamoto, Yosuke; Kyoto University, Department of Healthcare epidemiology
Primary Subject Heading:	Geriatric medicine
Secondary Subject Heading:	Epidemiology
Keywords:	successful aging, preventative healthcare, physical function, social capital

Social participation and the combination of future needs for long-term care and mortality among older Japanese people: A prospective cohort study from the Aichi Gerontological Evaluation Study (AGES)

Sei Takahashi, MD, MPH[a,b], Toshiyuki Ojima, MD, PhD[c], Katsunori Kondo, MD, PhD[d,e], Sayaka Shimizu, MD, PhD[b], Shunichi Fukuhara, MD, DMSc, MACP[a,b,f,g], Yosuke Yamamoto, MD, PhD[b]

[a] Center for Innovative Research for Communities and Clinical Excellence (CIRC^{2}LE), Fukushima Medical University, Fukushima, Japan

[b] Department of Healthcare and Epidemiology, School of Public Health, Kyoto University of Medicine, Kyoto, Japan

[c] Hamamatsu University School of Medicine, Hamamatsu, Japan

[d] Department of Gerontological Evaluation, Center for Gerontology and Social Science, National Center for Geriatrics and Gerontology, Japan

[e] Department of Social Preventive Medical Sciences, Center for Preventive Medical Sciences, Chiba University, Japan

[f] Department of Innovative Research and Education for Clinicians and Trainees (DiRECT), Fukushima Medical University Hospital, Fukushima, Japan

[g] Department of General Medicine, Shirakawa Satellite Teaching and Research (STAR), Fukushima Medical University, Fukushima, Japan

Corresponding author: Yosuke Yamamoto, Department of Healthcare and Epidemiology, School of Public Health, Kyoto University of Medicine, Kyoto 606-8501 Japan

E-mail: yamamoto.yosuke.5n@kyoto-u.ac.jp

Word count (excluding title page, abstract, references, figures, and tables): 2,986

ABSTRACT

OBJECTIVES: Our study aimed to examine the longitudinal association between social participation and both mortality and the need for long-term care (LTC) during a long-term, follow-up period.

DESIGN: A prospective-cohort study with 9.4 years of follow-up.

SETTING: Six Japanese municipalities.

PARTICIPANTS: The participants were 15,313 people who did not qualify to receive Long Term Care Insurance at a baseline based on the data from the Aichi Gerontological Evaluation Study (AGES, 2003–). They received a questionnaire to measure social participation and other potential confounders. Social participation was defined as participating in at least one organisation from eight categories.

PRIMARY AND SECONDARY OUTCOME MEASURES: The primary outcomes were classified into three categories at the end of the 9.4-year observational period: living without the need for LTC, living with the need for LTC, and death. We estimated the adjusted odds ratio (AOR) using multinomial logistic regression analyses with adjustment for possible confounders.

RESULTS: The primary analysis included 9,741 participants. Multinomial logistic regression analysis revealed that social participation was associated with a significantly lower risk of the need for LTC (AOR, 0.82; 95% CI, 0.69 to 0.97) or death (AOR, 0.78; 95% CI, 0.70 to 0.88).

CONCLUSIONS: Social participation may be associated with a decreased risk of the need for LTC and mortality among elderly patients.

Keywords: successful ageing; preventative healthcare; physical function; social capital

Strengths and Limitations of this Study

- ✓ The present study was based on a large cohort of community-dwelling older people which enabled us to accurately measure participants' need to receive care or survival with a median follow-up of 9.4 years and few dropouts.

- ✓ Using the combination of the two outcomes, we showed the prognosis of older people with or without social participation.

- ✓ The limitation of the study was that the cohort questionnaire only measured social participation at a baseline, and no measurements were obtained from the same participants during the follow-up periods.

- ✓ Further research will be required to evaluate the association between outcomes and social participation based on the measurement in several points, and then to examine whether an intervention of some social activity may decrease both the need for long-term care and death in older people.

INTRODUCTION

An ageing society is a major issue in developed countries as well as in some developing countries. In 2015, the United Nations reported that there were almost 901 million people over the age of 60, comprising 12% of the global population.[1] Japan is experiencing the most rapid global increase of an older population, with about 33% of its population consisting of people over the age of 60.[2] One of the major concerns of a rapidly ageing society is the social burden of older people who need care. In 2015, more than 5.6 million people, or 36.2% of people aged 65 and over, required care within the Japanese healthcare system.[3] These populational transitions would have enormous influence on our access to high quality health and social care. The World Health Organization has proposed the concept of 'Healthy Aging', defined as 'the process of developing and maintaining the functional ability that enables well-being in older age',[4] for all people to live long and healthy lives.

Recently, social capital has received increased attention because it may have some potential for preventing functional decline and death. Social participation has been defined by Putnam,[5] Berkman,[6] and various other researchers. It was defined by the WHO as a component of the social determinant of health and it contains various kinds of forms as follows: informing people with balanced, objective information; consulting, whereby the affected community provides feedback; involving or working directly with communities; collaborating by partnering with affected communities in each aspect of the decision making process, including the development of alternatives and the identification of solutions; and empowering people by ensuring that communities retain ultimate control over the key decisions that affect their wellbeing.[7] Previous studies have shown that social participation among older people is associated with a reduced risk of the need for long-term care (LTC)[8-11] or death.[12-16] However, previous studies have several limitations. For example, in studies that examined the relationship between social participation and the need

for LTC, patients who died were treated as censored cases or were not described in the results.[8-11] Other studies that investigated the association between social participation and mortality did not simultaneously analyse functional disability and death. For example, one study [13] investigated the relationship between social participation and functional decline and death, but these two outcomes were analysed separately instead of in a single model. Both functional disability and death are relevant outcomes for older people. No long-term, follow-up study has thus far elucidated the proportion of participants who require LTC or who die based on their degree of social participation.

We conducted a longitudinal cohort study to investigate the association between social participation and the need for LTC and death using the Aichi Gerontological Evaluation Study (AGES).

METHODS

Design and Setting

The relationship between social participation and the long-term outcomes of older people was analysed based on the Aichi Gerontological Evaluation Study (AGES) longitudinal data.[17] Participants were 65 and older and did not have physical or cognitive impairments at the baseline. The participants were randomly selected from six municipalities (Handa city, Tokoname city, Agui town, Taketoyo town, Minamichita town, and Mihama town) in Aichi prefecture, Japan. If the municipal population was less than or equal to 5,000, all people in the municipality were selected as participants. If the municipal population was greater than 5,000, 5,000 persons were randomly sampled using the resident registration list. In 2003, participants answered a self-reported questionnaire by mail, including questions about their health status, social participation, and socioeconomic status for the baseline survey data; they were followed up until the development of functional decline, eligibility for LTC, or death.

More information on AGES is available elsewhere.[17] The Kyoto University Ethics Committee approved this study (the number of approval: R0425). The Nihon Fukushi University Ethics Committee originally approved the AGES projects (the approval number: 13-14). Written informed consent was assumed with the voluntary return of the questionnaires.

Study Population

Eligible participants were individuals over the age of 65 who answered the AGES self-reported questionnaire in 2003. Participants who qualified to receive long-term care at the beginning of the observational period were excluded. We also excluded those who could not independently perform the activities of daily living (ADL) or who did not answer the questionnaire related to social participation.

Social Participation

We divided social participation into eight types based on a previous study:[9] neighbourhood associations/senior citizen clubs/fire-fighting teams (local community), hobby groups (hobby), sports groups or clubs (sports), political organisations or groups (politics), industrial or trade associations (industry), religious organisations or groups (religion), volunteer groups (volunteer), and citizen or consumer groups (citizen). The questions used to measure social participation were based on the Japanese version of the General Social Survey (JGSS).[18] Participants answered 'currently participate' or 'do not currently participate' for each type of social participation at the baseline. In the primary analysis, participants were categorised in the non-participation group (no participation in any group) or the social participation group (participation in at least one group).

Outcomes

The primary outcome was the need for LTC or death at the end of the 9.4-year observational period. The need for LTC was determined based on a formal evaluation in accordance with

routine criteria that combine a home visit evaluation with the judgment of the primary doctor.[19] Applicants or their family members essentially apply to their municipality for certification of LTC when the applicants find themselves in the need of some care support or when users' family members recognise that they need to introduce care support in the user's life. When applicants are certified, they would be classified as Needed Support or the need for LTC. The applicants with lighter functional decline (e.g. those who are ambulatory but find it difficult to walk long distances) are classified as Needed Support. The LTC certification is generally considered as the activities of daily life (ADL) that the applicant partially or wholly depends on others for.[20] We defined the reference category as 'without the need for LTC' and this category included those who were not certified or certified as Needed Support. Secondary outcomes were the incidence of the need for LTC or death at two and five years. We derived information on the certification of the need for LTC or death from the database provided by the municipalities. Data were also obtained regarding whether participants moved out of the area; we excluded participants who moved out at the end of the observational period before the start of the primary analysis.

Statistical Analysis

We described the baseline characteristics using means and standard deviations for the continuous variables and percentages for the categorical variables. Additionally, we showed the proportion of participants with each outcome by social participation group (yes or no), as well as by the number of types of social participation. In the primary analysis, we performed multinomial logistic regression analyses with adjustment for possible confounders (age per five-year increment), gender, living alone, educational attainment (more than nine years), smoking, alcohol consumption, walking time (more than thirty minutes per day), annual household income (more than 3,000,000 yen per year), and the number of comorbidities (one or more than two) to examine the relationship between social participation and the

development of each outcome (the need for LTC or death) during the 9.4-year follow-up. Missing data for all variables were not imputed.

In the secondary analysis, we examined the relationship between each type of social participation and outcomes (the need for LTC or death) during the 9.4-year follow-up using multinomial logistic regression with adjustment for the same confounders as above. Using the model above, we then investigated the number of types of social participation and outcomes. Participants were placed into one of four categories: people with no social participation, one type of social participation, two types of social participation, and at least three or more types of social participation. Furthermore, we conducted multinomial logistic analysis regarding outcomes at two and five years with adjustment for the same confounders as above.

Finally, we performed a sensitivity analysis, changing one of the outcome definitions from the development of LTC to the certification of Needed Support using a multinomial logistic model with adjustment for the same confounders as listed above. Certification for Needed Support indicates that ADL and instrumental ADL could mostly be performed independently, but some daily support was required. The tendency for functional decline is generally milder than those who need LTC.

All analyses were performed using STATA version 14.2 (Stata Corp., LP, College Station, TX, USA). A p-value <0.05 was considered statistically significant.

Patient and public involvement

No participants were involvement in establishing the research question, outcome measures including the study design, and interpretation. We will disseminate the results through the website and on social media.

RESULTS

Baseline Characteristics

Figure 1 shows the flow diagram of the study. Among 15,313 participants, 9,863 (73.6%) were in the social participation group. The mean age was 72.5 in participants with social participation and 72.9 in those without social participation. The highest proportion of social participation was seen in local community and hobby groups. Around 10% of the social participation group participated in political groups, industrial groups, religious groups, and volunteer groups. The proportion of higher educational attainment and higher household income was about 10% higher in the social participation group. Thus, participants who engaged in social participation were likely to present higher educational attainment and higher household income than those who were not (Supplementary Table S1). Figure 2 shows the proportion of participants who developed each outcome at 2, 5, and 9.4 years. At the end of the observational period, in those engaged in social participation, 6,463 participants (67.5%) lived without the need for LTC, 839 (8.8%) lived with the need for LTC, and 2,275 participants (23.7%) had died.

Primary Analysis

The primary analysis included 9,741 participants. Multivariable multinomial logistic regression analysis showed that participants who engaged in social participation were significantly less likely to develop the need for LTC or die than those who were not engaged in social participation during the 9.4-year follow-up period: adjusted odds ratio (AOR) 0.82, 95% confidence interval [CI], 0.69-0.97; AOR= 0.78; 95% CI: 0.70-0.88, respectively (Table 1).

Table 1. Multinomial logistic regression analysis: Association between social participation and the need for LTC or death at 9.4 years (N = 9,741) AOR (95% CI) - Reference category:

Without the need for LTC and death

Variable	Survival with the need for LTC 845 (8.7) AOR (95% CI)	Death 2,443 (25.1) AOR (95% CI)
Social participation (yes)	0.82 (0.69-0.97)*	0.78 (0.70-0.88)**
Age (per 5 years)	2.06 (1.93-2.19)**	2.16 (2.06-2.26)**
Gender (men)	0.80 (0.67-0.95)*	1.98 (1.76-2.24)**
Family (living alone)	1.03 (0.78-1.31)	0.91 (0.74-1.11)
Educational attainment (more than 9 years)	0.92 (0.79-1.08)	0.94 (0.85-1.05)
Smoking (yes)	1.50 (1.19-1.88)**	1.74 (1.51-2.00)**
Alcohol (yes)	1.05 (0.86-1.30)	0.92 (0.81-1.05)
Walking time (more than 30 min/day)	0.80 (0.69-0.94)**	0.73 (0.66-0.81)**
Household income (more than 3,000,000 Yen/year)	0.88 (0.75-1.03)	0.96 (0.86-1.07)
One comorbidity	1.39 (1.10-1.75)**	1.28 (1.10-1.50)**
Two or more comorbidities	1.59 (1.27-1.98)**	1.67 (1.45-1.94)**

*: $p<0.05$, **: $p<0.01$.

Note: LTC, long-term care; AOR, adjusted odds ratio; CI, confidence interval.

Secondary Analysis

Multinomial logistic regression analysis was performed to examine the relationship between

each type of social participation and the outcomes. The results showed that participants in local community, hobby, and sports groups were significantly less likely to die than those without participation in these groups (AOR= 0.85, 95% CI: 0.73-0.99; AOR= 0.71, 95% CI: 0.60-0.85; and AOR= 0.65, 95% CI: 0.52-0.80, respectively). On the other hand, participants in religious organisations or groups were significantly more likely to develop the need for LTC than those without such participation (AOR= 1.33, 95% CI: 1.08-1.65) (Table 2).

Table 2. Multinomial logistic regression analysis: Association between each type of social participation and the incidence of the need for LTC or death at 9.4 years (N = 9,741) AOR (95% CI) - Reference category: Without the need for LTC and death

	Survival with the need for LTC	Death
	AOR (95% CI)	AOR (95% CI)
Social participation group, n (%)[a]	845 (8.7)	2,443(25.1)
Local community 5,692 (58.4)	0.85 (0.73-0.99)*	0.84 (0.76-0.93)*
Hobby groups 3,101 (31.8)	0.71 (0.60-0.85)*	0.70 (0.63-0.79)*
Sports groups or clubs 2,067 (21.1)	0.65 (0.52-0.80)*	0.64 (0.56-0.73)*
Political organisations or groups 820 (8.4)	1.08 (0.82-1.43)	1.04 (0.87-1.25)
Industrial or trade associations 1,040 (10.7)	1.02 (0.79-1.33)	1.01 (0.86-1.20)
Religious organisations or groups 1,114 (11.4)	1.33 (1.08-1.65)*	1.15 (0.98-1.34)
Volunteer groups 1,052 (10.8)	0.86 (0.66-1.13)	0.98 (0.83-1.17)
Citizen or consumer groups 456 (4.7)	1.03 (0.71-1.48)	1.15 (0.90-1.46)

*: $p<0.05$, **: $p<0.01$.

Note: LTC, long-term care; AOR, adjusted odds ratio; CI, confidence interval.

[a]Adjusted age, gender, living alone or not, educational attainment, smoking, alcohol, walking time, household income, and the number of comorbidities.

With regard to the association between the number of types of social participation and the incidence of the need for LTC or death at the 9.4-year follow-up, results showed that participants who engaged in two types of social participation were less likely to die than those without any participation (AOR= 0.76, 95% CI: 0.65-0.88). Participants who engaged in three or more types of social participation were less likely to develop the need for LTC or die than participants without any participation (AOR= 0.67, 95% CI: 0.53-0.85; AOR= 0.67, 95% CI: 0.57-0.78, respectively) (Table 3).

Table 3. Multinomial logistic regression analysis: Relationship between the number of types of social participation and the need for LTC and death at 9.4-years (N = 9,741) AOR (95% CI) - Reference category: Without the need for LTC and death

	Survival with the need for LTC	Death
No. of participants, n (%)	AOR（95% CI）	AOR（95% CI）
Social participation group, n (%)[a]	845(8.7)	2,443(25.1)
One social group, 2,994 (30.7)	0.86 (0.71-1.05)	0.88 (0.77-1.01)
Two social groups, 2,192 (22.5)	0.92 (0.74-1.13)	0.76 (0.65-0.88)**
Three or more social groups, 2,174 (22.3)	0.67 (0.53-0.85)**	0.67 (0.57-0.78)**

*: p<0.05, **: p<0.01.

Note: LTC, long-term care; AOR, adjusted odds ratio; CI, confidence interval

[a]Adjusted age, gender, living alone or not, educational attainment, smoking, alcohol, household income, walking time, and the number of comorbidities

After two years of follow-up, participants who were engaged in social participation were significantly less likely to develop the need for LTC than those without participation (AOR= 0.45; 95% CI: 0.32-0.64). After five years of follow-up, participants who engaged in social participation were less likely to develop the need for LTC and die than those without social participation (AOR= 0.68; 95% CI: 0.54-0.86; AOR= 0.83; 95% CI: 0.71-0.96, respectively) (Supplementary Table S2).

Sensitivity Analysis

In sensitivity analysis, the results indicated that participants who participated in social groups were less likely to develop the need for Needed Support than those who were not (AOR= 0.93; 95% CI: 0.81-1.07); however, the results were not statistically significant (Supplementary Table S3).

DISCUSSION

This study showed the association between social participation and the need for LTC or death during 9.4 years of follow-up. At the end of the follow-up period, participants who were engaged in social participation were more likely to remain functionally independent than participants who were not engaged in social participation. The results were significant in all

of the primary outcomes in the multinomial logistic regression analysis adjusted for confounding factors. Furthermore, a relationship was seen between the number of types of social participation and each outcome, suggesting that engaging in many varieties of participation may be more effective on the health of participants than a few varieties of participation. The secondary analyses based on the two- and five-year follow-up were similar to the results of the primary analysis. Sensitivity analysis was performed by examining the results from living with and without mild impairment and using the outcome criteria as a person's history of Certification of Needed Support. The findings were similar to those of the main analysis.

The results of the present study support previous studies, but these studies evaluated only one outcome (the need for LTC or death) [8-11, 12-16] and did not take both outcomes into account in a single model.[14] The present study is the first to focus on the combination of two relevant outcomes in the same model.

We defined and classified social participation from the baseline questionnaire to a binary variable denoting the presence or absence of any social participation and adopted it onto the main analysis. Further, we conducted secondary analysis using the original eight-type classification of social participation based on the JGSS questionnaire.[18] The results of the secondary analysis showed that several types of social participation were associated with lower incidences of LTC and mortality. Our results indicated that specific types of social participation may be effective for long-term care and mortality. Although it was difficult for us to know the detailed contents of these forms of participation from the baseline questionnaire, local community, hobby groups, and sports groups or clubs may be effective in contributing to participants' future health. In particular, our results indicate that participation in sports groups is the most effective form of social participation listed in our questionnaire. Previous studies have revealed that participation in sports clubs means that

participants would be less likely to develop the need for LTC than if exercising alone.[8] Therefore, participation in sports clubs may contribute to healthy ageing so we might as well recommend the national and local politics to grow more interests in the participation in sports clubs or groups.

The mechanisms regarding why and how social participation affects healthy ageing and death are not yet known, but growing evidence suggests that social participation stimulates the body and brain, helping participants remain highly functional.[12, 21] Another study suggested that participants who engage in social participation may have easier access to social support.[22] With regard to biomedical mechanisms, social participation may suppress inflammatory markers such as interleukin-6 or C-reactive protein and reduce physical stress.[23] Further studies are needed to reveal the underlying mechanisms regarding the relationship between social participation and healthy ageing, i.e. what kind of form or content of participation may sustain the health of older people or the frequency of social participation that may maintain a participant's health or their health-related behaviours. To analyse the relationship between a participant's behaviours and health-related outcomes will be beneficial not only for the individual's health, but also for policy makers who are trying to promote social participation.

The strength of the present study is that it is the first study to use composite outcomes of both the need for care support and death to examine the relationship between social participation and the elderly's relevant outcomes. This study found that social participation may reduce both the need for care support and death. It is also worthwhile to describe the proportions of each outcome in this long-term study. By using outcomes that include the presence or absence of healthy ageing, we were able to show the prognosis in detail after the long-term observation of older people. Moreover, the AGES cohort is a relatively large-scale study. The proportion of participants lost to follow-up was low (3.4%), even after 9.4 years.

However, there are several limitations to this study. First, the measurement of social participation was only performed at the baseline. No measurements were obtained during the follow-up periods. Second, social participation is a subset of social capital as described by Putnam.[5] It has been measured in various ways as an indicator that measures the quality of the social network. The questions in this study were designed to measure only the presence or absence of social participation. We could not use the information regarding the intensity and duration of social participation. Third, there was no information about dementia or cerebrovascular disease in this study, which are two of the main causes of death among elderly patients.[24] Fourth, multinomial logistic analysis may be superior to previous methods to compare the elderly's need for LTC and death without the need for LTC, but other methods such as the competing risk regression model may be suggested when we focus separately on the incidence of LTC. Fifth, this study used data taken from a single area; thus, the generalizability of results to other areas or countries cannot be assumed. Finally, the present study is observational; thus, we could not adjust for the effect of unknown confounding factors in the association between social participation and outcomes, or prove a causal effect between social participation and outcomes.

In conclusion, this study indicated that social participation may not only reduce the risk of death, but also reduce the risk of developing a disability. Living with disability in the midst of a super-ageing society not only impairs the quality of life of the individual, but also places an additional burden on society. Further research is needed to examine whether an intervention that encourages social participation may reduce death and functional disability among the elderly.

ACKNOWLEDGEMENTS

The authors thank all staff members in each study area and in the central office for their painstaking efforts in conducting the baseline survey and follow-up. We would also like to express our deepest gratitude to everyone who participated in the survey. We also thank Editage (www.editage.jp) for its English language editing services.

COMPETING INTERESTS

The authors have no conflicts to declare.

FUNDING

This work was supported by JSPS KAKENHI Grant Number JP18390200 and Health Labour Sciences Research Grant, Comprehensive Research on Ageing and Health (H22-Choju-Shitei-008) from the Japanese Ministry of Health, Labour, and Welfare.

DATA SHARING STATEMENT

The data were acquired from the JAGES study. All enquiries are to be addressed to the data management committee via e-mail: dataadmin.ml@jages.net. All JAGES datasets have ethical or legal restrictions for public deposition due to the inclusion of sensitive information

from human participants. Following the regulation of local governments that cooperated in our survey, the JAGES data management committee has imposed these restrictions on the data.

AUTHOR CONTRIBUTIONS

ST and TO conceived of the idea. ST, YY, SS, and SF contributed to the study design. TO and KK contributed to defining the data variables and the acquisition of the data. ST and YY performed statistical analysis, interpreted the data, and drafted the manuscript. TO, KK, SS, and SF reviewed the manuscript. All authors revised the manuscript for intellectual content and approved the final submission.

SPONSOR'S ROLE: The grant sponsors had no role in the design, methods, participant recruitment, data collection, analysis, or preparation of this paper.

REFERENCES

1 United Nations. World Population Prospects (online). Available at: https://esa.un.org/unpd/wpp/publications/files/key_findings_wpp_2015.pdf. Accessed November 17, 2017.

2 Statistics of Japan. List of Statistical Tables (online). Available at: http://www.e-stat.go.jp/SG1/estat/GL38020103.do?_toGL38020103_&tclassID=00000 1077438&cycleCode=0&requestSender=estat. Accessed December 5, 2017.

3 Cabinet Office Government of Japan. Annual Report on the Aging Society: 2016 (Summary) (online). Available at: http://www8.cao.go.jp/kourei/whitepaper/w-2016/html/gaiyou/index.html. Accessed March 7, 2017.

4 WHO | What is Healthy Ageing? WHO. 2018. https://www.who.int/ageing/healthy-ageing/en/. Accessed June 29, 2019.

5 Putnam RD. Bowling alone: America's declining social capital. *J Democr* 1995;6:65–78.

6 Berkman LF. The role of social relations in health promotion. *Psychosom Med* 1995;57(3):245-254. http://www.ncbi.nlm.nih.gov/pubmed/7652125. Accessed July 2, 2019.

7 WHO | Social participation. WHO. 2013. https://www.who.int/social_determinants/thecommission/countrywork/within/socialpart icipation/en/. Accessed July 2, 2019.

8 Kanamori S, Kai Y, Kondo K, et al. Participation in sports organizations and the prevention of functional disability in older Japanese: the AGES Cohort Study. *PLoS One* 2012;7:e51061.

9 Kanamori S, Kai Y, Aida J, et al. Social participation and the prevention of functional

disability in older Japanese: the JAGES cohort study. *PLoS One* 2014;9:e99638.

10 Murata C, Saito T, Tsuji T, et al. A 10-year follow-up study of social ties and functional health among the old: the AGES project. *Int J Environ Res Public Health* 2017;14:pii:E717.

11 Saito M, Aida J, Kondo N, et al. Reduced long-term care cost by social participation among older Japanese adults: a prospective follow-up study in JAGES. *BMJ Open* 2019;9(3):e024439.

12 Aida J, Kondo K, Hirai H, et al. Assessing the association between all-cause mortality and multiple aspects of individual social capital among the older Japanese. *BMC Public Health* 2011;11:499.

13 Kawachi I, Colditz GA, Ascherio A, et al. A prospective study of social networks in relation to total mortality and cardiovascular disease in men in the USA. *J Epidemiol Community Health* 1996;50:245–51.

14 Hsu HC. Does social participation by the elderly reduce mortality and cognitive impairment? *Aging Ment Health* 2007;11:699–707.

15 Glass TA, de Leon CM, Marottoli RA, et al. Population based study of social and productive activities as predictors of survival among elderly Americans. *BMJ* 1999;319:478–83.

16 Väänänen A, Murray M, Koskinen A, et al. Engagement in cultural activities and cause-specific mortality: prospective cohort study. *Prev Med* 2009;49:142–7.

17 Nishi A, Kondo K, Hirai H, et al. Cohort profile: the AGES 2003 cohort study in Aichi, Japan. *J Epidemiol* 2011;21:151–7.

18 Iwai N. Japanese General Social Surveys (JGSS) and measurements of family and gender attitudes: Results of the 1st Preliminary Survey. *Kazoku Syakaigaku Kenkyu* 2001;12:261–70 (in Japanese).

19 Tsutsui T, Muramatsu N. Care-needs certification in the long-term care insurance system of Japan. *J Am Geriatr Soc* 2005;53:522–7.

20 Matsuda S, Muramatsu K, Hayashida K. Eligibility classification logic of the Japanese Long Term Care Insurance. *Asian Pacific J Dis Manag* 2011;5(3):65-74.

21 Erickson KI, Voss MW, Prakash RS, et al. Exercise training increases size of hippocampus and improves memory. *Proc Natl Acad Sci U S A* 2011;108:3017–22.

22 Zhang W, Chen M. Psychological distress of older Chinese: exploring the roles of activities, social support, and subjective social status. *J Cross Cult Gerontol* 2014;29:37–51.

23 Glei DA, Goldman N, Ryff CD, et al. Social relationships and inflammatory markers: an analysis of Taiwan and the U.S. *Soc Sci Med* 2012;74:1891–9.

24 Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare. Graphical Review of Japanese Household (online). Available at: http://www.mhlw.go.jp/toukei/list/dl/20-21-h25.pdf. Accessed March 7, 2017.

FIGURE LEGENDS

Figure 1. Flow diagram of the study.

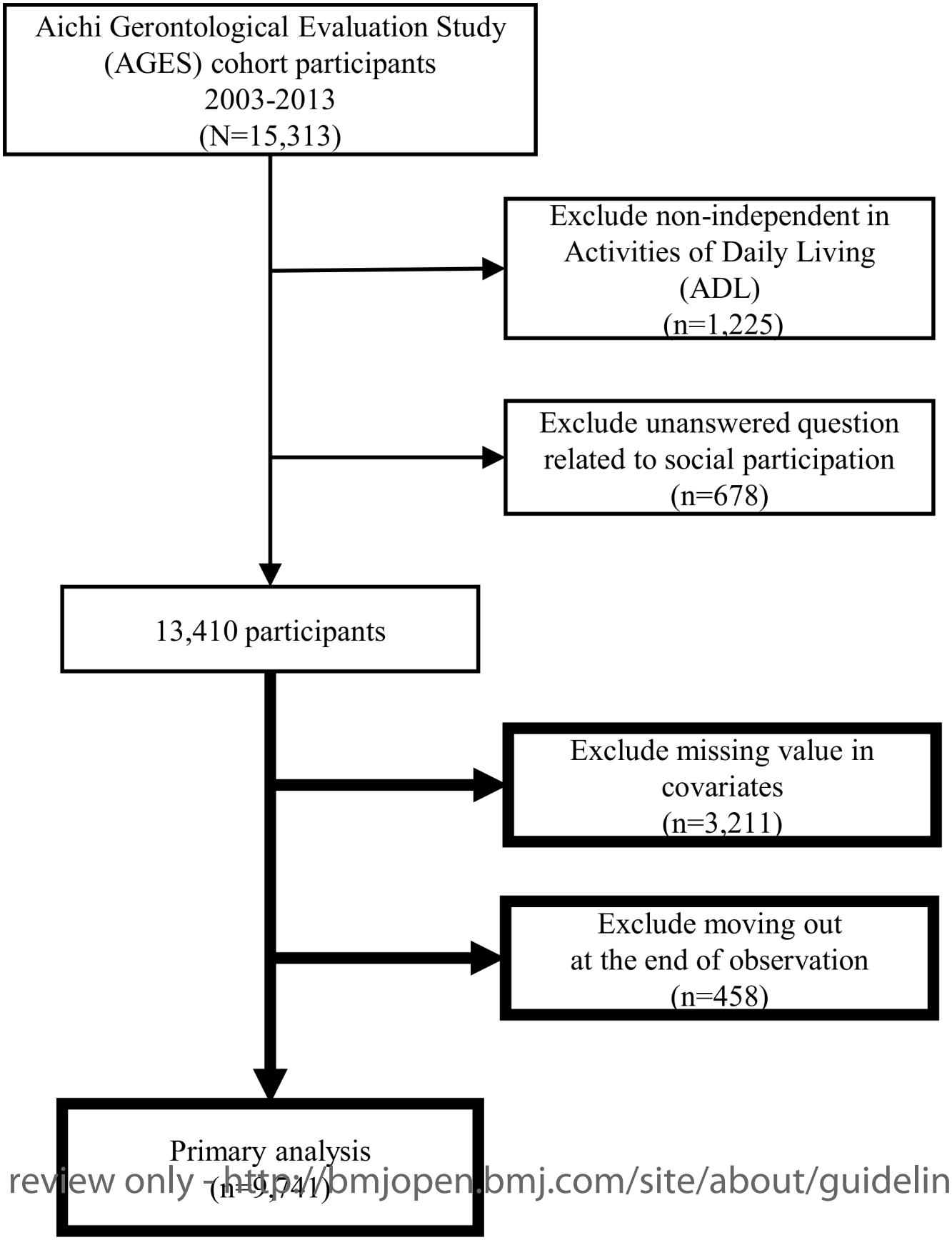
Figure 2. Incidence of the need for LTC and death at 2 years, 5 years, and 9.4 years.

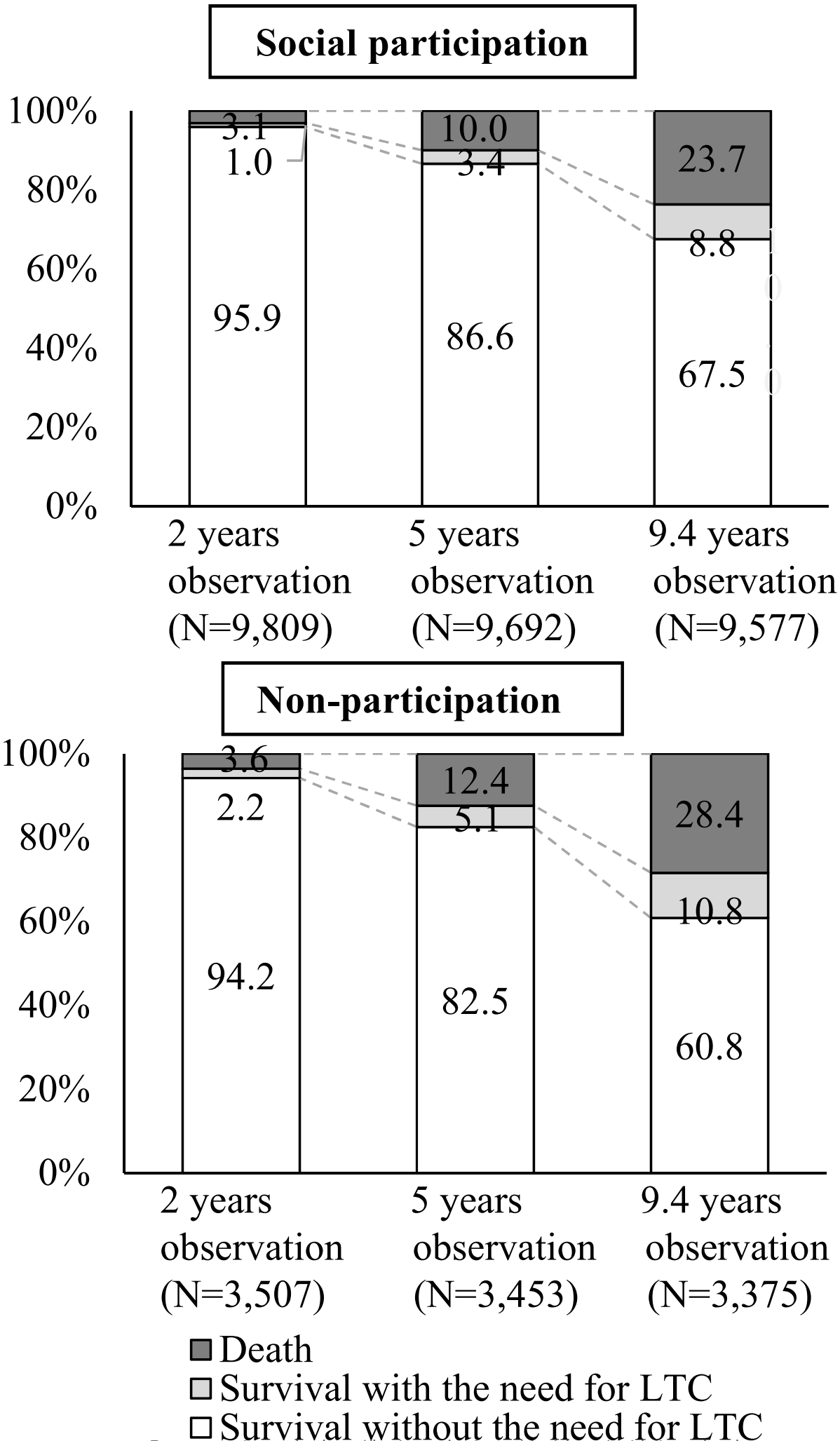
SUPPLEMENTAL INFORMATION

Supplementary Table S1. Baseline characteristics

Supplementary Table S2. Multinomial logistic regression analysis: Association between social participation and the incidence of the need for LTC and death at two and five years - Reference category: Without the need for LTC and death

Supplementary Table S3. Multinomial logistic regression analysis: Association between social participation and the incidence of the Certification of Needed Support and death at 9.4 years (N = 9,741) - Reference category: Without the certification of Needed Support




Social participation
100%
80%
60%
40%
20%
0%
3.1
1.0
95.9
10.0
3.4
86.6
23.7
8.8
67.5
2 years observation (N=9,809)
5 years observation (N=9,692)
9.4 years observation (N=9,577)
Non-participation
3.6
2.2
94.2
12.4
5.1
82.5
28.4
10.8
60.8
2 years observation (N=3,507)
5 years observation (N=3,453)
9.4 years observation (N=3,375)
Death
Survival with the need for LTC
Survival without the need for LTC

Supplementary Table S1. Baseline characteristics

		Social participation	Non-participation	Total
N (%)		9,863 (73.6)	3,547 (26.5)	13,140
Age, y	Average ± Standard deviation	72.5±5.7	72.9±6.3	72.6±5.8
Gender (%)	Men	4,902 (49.7)	1,696 (47.8)	6,598 (49.2)
Social participation (%)	Local community	7,613 (77.2)	-	7,613 (56.8)
	Hobby groups	4,045 (41.0)	-	4,045 (30.2)
	Sports groups or clubs	2,671 (27.1)	-	2,671 (19.9)
	Political organization or groups	1,029 (10.4)	-	1,029 (7.7)
	Industrial or trade associations	1,298 (13.2)	-	1,298 (9.7)
	Religious organizations or groups	1,544 (15.7)	-	1,544 (11.5)
	Volunteer groups	1,330 (13.5)	-	1,330 (9.9)
	Citizen or consumer groups	623 (6.3)	-	623 (4.7)
Family status	Living alone	936 (9.5)	374 (10.5)	1,310 (9.8)
	Missing	0 (0.0)	0 (0.0)	0 (0.0)
Educational attainment	More than 9 years	4,291 (43.5)	1,185 (33.4)	5,476 (40.8)
	Missing	77 (0.8)	46 (1.3)	123 (0.9)
Smoking	Current smoker	1,190 (12.1)	511 (14.4)	1,701 (12.7)
	Missing	291 (3.0)	171 (4.8)	462 (3.5)
Alcohol	Current drinker	2,161 (21.9)	638 (18.0)	2,799 (20.9)
	Missing	129 (1.3)	71 (2.0)	200 (1.5)
Walking time	More than 30 min/day	5,952 (60.4)	1,904 (53.7)	7,856 (58.6)
	Missing	890 (9.0)	403 (11.4)	1,293 (9.6)
Household income	More than 3,000,000 yen/year	5,389 (54.6)	1,488 (42.0)	6,877 (51.3)
	Missing	1,404 (14.2)	666 (18.8)	2,070 (15.4)
Numbers of comorbidity	One	3,415 (34.6)	1,239 (34.9)	4,654 (34.7)
	Two or more	4,516 (45.8)	1,614 (45.5)	6,130 (45.7)
	Missing	0 (0.0)	0 (0.0)	0 (0.0)

Supplementary Table S2. Multinomial logistic regression analysis: Association between social participation and the incidence of the need for LTC and death at two and five years - Reference category: Without need for LTC

Follow-up period	Survival with need for LTC	Death
Two years (n = 10,019)		
No. of participants, n (%)	136 (1.4)	333 (3.3)
Social participation (yes)		
AOR (95% CI)[a]	0.45 (0.32-0.64)**	0.92 (0.71-1.18)
Five years (n = 9,888)		
No. of participants, n (%)	346 (3.5)	1,047 (10.6)
Social participation, yes		
AOR (95% CI)[a]	0.68 (0.54-0.86)**	0.83 (0.71-0.96)*

*: $p<0.05$, **: $p<0.01$.

Note: LTC, long-term care; AOR, adjusted odds ratio; CI, confidence interval.

[a]Adjusted for age, gender, living alone, education, smoking, alcohol, household income, walking time, and number of comorbidities

Supplementary Table S3. Multinomial logistic regression analysis: Association between social participation and the incidence of the certification of Needed Support and death at 9.4 years (N = 9,741) - Reference category: Without the certification of Needed Support

	Survival with the certification of Needed Support	Death
	1,263 (13.0)	1,758 (18.1)
Variable	AOR (95% CI)	AOR (95% CI)
Social participation (yes)	0.93 (0.81-1.07)	0.78 (0.69-0.89)**
Age (per 5 years)	2.36 (2.23-2.50)**	2.45 (2.45-2.72)**
Gender (men)	0.66 (0.57-0.75)**	1.78 (1.57-2.01)**
Family (living alone)	1.04 (0.85-1.28)	0.92 (0.74-1.13)
Education (more than 9 years)	0.99 (0.88-1.12)	0.95 (0.85-1.06)
Smoking (yes)	1.45 (1.20-1.74)**	1.82 (1.58-2.11)**
Alcohol (yes)	0.97 (0.82-1.14)	0.91 (0.80-1.04)
Walking time (more than 30 min/day)	0.85 (0.75-0.96)*	0.72 (0.64-0.80)**
Household income (more than 3,000,000 yen/year)	0.81(0.71-0.92)**	0.92 (0.82-1.03)
One comorbidity	1.44 (1.21-1.73)**	1.32 (1.13-1.55)**
Two or more comorbidities	1.97 (1.66-2.34)**	1.87 (1.61-2.17)**

*: $p<0.05$, **: $p<0.01$.

Note: AOR, adjusted odds ratio; CI, confidence interval.

Reporting checklist for cohort study.

Based on the STROBE cohort guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

Upload your completed checklist as an extra file when you submit to a journal.

In your methods section, say that you used the STROBE cohort reporting guidelines, and cite them as:

von Elm E, Altman DG, Egger M, Pocock SJ, Gotzsche PC, Vandenbroucke JP. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies.

		Reporting Item	Page Number
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	2

Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	#3	State specific objectives, including any prespecified hypotheses	4-5
Study design	#4	Present key elements of study design early in the paper	5
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up.	6
	#6b	For matched studies, give matching criteria and number of exposed and unexposed	-
Variables	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	5-6
Bias	#9	Describe any efforts to address potential sources of bias	13
Study size	#10	Explain how the study size was arrived at	9

Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	6-8
Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	7-8
	#12b	Describe any methods used to examine subgroups and interactions	7-8
	#12c	Explain how missing data were addressed	7-8
	#12d	If applicable, explain how loss to follow-up was addressed	-
	#12e	Describe any sensitivity analyses	7-8
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	9
	#13b	Give reasons for non-participation at each stage	9
	#13c	Consider use of a flow diagram	9
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	9

	#14b	Indicate number of participants with missing data for each variable of interest	8
	#14c	Summarise follow-up time (eg, average and total amount)	9
Outcome data	#15	Report numbers of outcome events or summary measures over time. Give information separately for exposed and unexposed groups if applicable.	9
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9
	#16b	Report category boundaries when continuous variables were categorized	7-8
	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	10-13
Key results	#18	Summarise key results with reference to study objectives	13-14
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	15-16

Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	13-15
Generalisability	#21	Discuss the generalisability (external validity) of the study results	16
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17