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Preventive impact of social participation on the onset of non-communicable diseases among middle-aged adults: A 10-wave hazards-model analysis in Japan

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ABSTRACT

Social participation (SP) is known to have a favorable impact on the health of older adults by reducing the risk of functional disability, psychological distress, cognitive impairment, and mortality. However, the preventive impact of SP on non-communicable diseases (NCDs) among middle-aged adults is largely understudied. Using the dataset from a population-based, 10-wave longitudinal survey that started with Japanese adults aged 50–59 years in 2005 (16,290 men and 17,248 women), we estimated Cox proportional hazards models to estimate the preventive impact of SP adjusted for baseline covariates. After controlling for baseline covariates, baseline participation in at least one of six types of SP prevented diabetes both for men (hazard rate [HR] = 0.86; 95% confidence interval [CI] = 0.77, 0.95) and women (HR = 0.75; 95% CI = 0.66, 0.85) and stroke both for men (HR = 0.83; 95% CI = 0.70, 0.99) and women (HR = 0.78; 95% CI = 0.64, 0.97). SP also had a preventive impact on hypertension only for women (HR = 0.91; 95% CI = 0.84, 0.99). SP did not prevent heart disease, hyperlipidemia, or cancer for either gender. We also found that SP tended to have a stronger preventive effect when it was conducted with other persons than done alone, highlighting personal interactions as a key aspect of SP for later health outcomes. Overall, the results showed that SP can prevent the onset of selected NCDs, suggesting that policy measures to encourage SP may be favorable for the health of middle-aged adults.

1. Introduction

Social participation (SP) is known to have a favorable impact on the health of elderly adults. Many longitudinal studies have shown that such SP experiences at baseline as participating in community work, sports/hobby clubs, and volunteer activities, prevented the onset of functional disability (Ashida et al., 2016; Kanamori et al., 2014; James et al., 2011a; Tomioka et al., 2017), psychological distress (Amagasa et al., 2017; Chiao et al., 2011; Fu et al., 2017), and cognitive impairment (Bourassa et al., 2017; Hsu, 2007; James et al., 2011b), and delayed mortality (Glass et al., 1999; Hsu, 2007; Väänänen et al., 2009). Relatedly, studies have observed that community-based social capital and social networks, concepts that largely overlap with SP, were negatively associated with risk of deterioration in health (Aida et al., 2011; Aida et al., 2013; Fujiwara and Kawachi, 2008; Iwasaki et al., 2002). These observations suggest that personal interactions with others have an important preventive impact on health deterioration among elderly adults. As pointed out by Levasseur et al. (2010), the involvement in activities that include interactions with others in the society or community are considered a core of the definition of SP in empirical studies.

Building on these preceding studies, we conducted a hazards-model analysis to examine the association between SP at baseline and health in subsequent years, using data from a population-based, 10-wave cohort survey in Japan. We intended to provide new insights into the understanding of the relevance of SP to health in two ways. First, unlike many preceding studies that used datasets consisting of participants aged 65 years and above, we focused on middle-aged adults who were 50–59 years old at baseline, to examine how SP might be predictive of future health risk. It is reasonable to suspect that individuals' decisions on SP may be less constrained by current health conditions among middle-aged adults than elderly ones. Hence, an analysis using data on

Abbreviations: HR, hazard rate; MHLW, Japanese Ministry of Health, Labour and Welfare; SP, social participation; NCDs, non-communicable diseases

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younger participants was expected to capture a more unbiased association between SP and later health outcomes.

Second, and more importantly, we examined whether and to what extent SP would prevent each major non-communicable disease (NCD) in comparison with functional disability and psychological distress. One might argue that the preventive impact of SP on NCDs is relatively limited because each NCD is likely to be affected by several specific health-risk factors other than SP. However, if SP experience is found to be at least partly predictive of any NCD, especially after controlling for other factors, that knowledge would have valuable implications for preventive healthcare. Some studies have provided evidence about the preventive impact of SP on coronary heart disease (Sundquist et al., 2004) and hypertension (Tu et al., 2018; Yazawa et al., 2016), but little has been known about other NCDs, and the impact of SP has not been compared across NCDs.

In the current study, based on the general observations obtained from preceding studies that used older subjects and focused on other health outcomes, we tentatively hypothesized that the SP experience would prevent the onset of NCDs among middle-aged adults. Simultaneously, we predicted that the preventive impact of SP might differ by NCD type and by gender. Further, to evaluate the importance of personal interactions with others in SP, we examined how different types of SP—that is, engaging in activities with others or doing them alone—affected the association between SP and health outcomes.

2. Methods

2.1. Study sample

We used data obtained from a nationwide, 10-wave panel survey called "The Longitudinal Survey of Middle-Aged and Older Adults," which was conducted by the Japanese Ministry of Health, Labour and Welfare (MHLW) each year from 2005 to 2014. Japan's Statistics Law required the survey to be reviewed from statistical, legal, ethical, and other viewpoints. We obtained the survey data from the MHLW with its official permission; therefore, the current study did not require ethical approval.

The sample in the first wave was limited to those aged 50–59 years. This nationwide sample was selected in November 2005 through a two-stage random sampling procedure. A total of 34,240 individuals responded (response rate: 83.8%). The second to tenth waves of the survey were conducted in early November of each year from 2006 to 2014, and 22,748 individuals remained in the tenth wave (average attrition rate of 4.0% in each wave). No new respondents were added after the first wave.

To capture the preventive impact of SP on the onset of each NCD, we focused only on the respondents who did not report its incidence at baseline (Wave 1). Additionally, we excluded those missing key variables from the statistical analysis. Thus, the number of respondents used for the statistical analysis ranged from 25,823 to 30,774, depending on health outcomes.

2.2. Measures

We considered the following six types of SP: "hobbies or cultural activities," "exercise or sports," "community events," "support for children," "support for the elderly," and "other activities." We constructed a binary variable in which we allocated one to the respondents who reported that they participated in at least one of these six types of SP at baseline and zero to others. We also considered whether SP was conducted alone or with other persons (such as friends and neighbors); we constructed a binary variable of "SP with others" (for those who participated with others in at least one type of SP) and "SP alone" (for those who participated alone in any type of SP).

We focused on the following six types of NCDs: diabetes, heart disease, stroke, hypertension, hyperlipidemia, and cancer. For each NCD, the respondents were asked whether they had been diagnosed with it by a medical doctor at the survey time. We constructed a binary variable in which we allocated one to the respondents who reported being diagnosed and zero to others. In addition to NCDs, we considered functional disability and psychological distress. For functional disability, we considered whether the respondent required assistance in at least one of ten aspects of activities of daily living: walking, getting out of bed, sitting on and rising from a chair, dressing, grooming, eating, toileting, bathing, climbing up and down stairs, and lifting and carrying objects. We measured psychological distress using the Kessler et al.'s (2002, 2010) Psychological Distress Scale, version K6. Our respondents were asked to answer a six-item questionnaire that included such items as "During the past 30 days, about how often did you feel (a) nervous, (b) hopeless, (c) restless or fidgety, (d) so depressed that nothing could cheer you up, (e) that everything was an effort, or (f) worthless?" The questions were rated on a 5-point scale (0 = none of the time to 4 = all of the time). Then, the sum of the reported scores (range: 0–24) was calculated and defined as the K6 score. Higher K6 scores reflect higher levels of psychological distress, and K6 scores ≥ 13 indicate serious mental illness in a Japanese sample, as validated by preceding studies (Furukawa et al., 2008; Sakurai et al., 2011). We constructed a binary variable for psychological distress by assigning one to those with K6 scores ≥ 13 and zero to others.

We included covariates, which we divided into two groups, in our regression analysis. The first set of covariates pertained to the time-invariant individual attribute: educational attainment (graduated from college or above, high school, junior high school, and others and not answered). The second included the following baseline variables: age, household spending, current smoking, heavy alcohol consumption, and self-rated health (SRH). Household spending, which was used as a proxy for household income, was adjusted for household size by dividing it by the square root of the number of household members. It was then categorized into quartiles. We considered a participant who answered "yes" to the question "Do you smoke currently?" to be a current smoker. We defined heavy alcohol consumption as an intake of more than three *go* (540 ml) of Japanese sake or an equivalent amount of alcohol every day, which corresponds to about 60 g of pure alcohol for men, and 30 g for women. These thresholds were based on a study that showed that maintaining alcohol consumption below 46 g/day for men and 23 g/day for women, appeared to minimize the risks of mortality in a Japanese population (Inoue et al., 2012). Regarding SRH, respondents were asked to answer on a six-point scale: 1 (very good), 2 (good), 3 (somewhat good), 4 (somewhat poor), 5 (poor), or 6 (very poor) regarding their current health condition. We combined 1 and 2, 3 and 4, and 5 and 6 into three categories: good, average, and poor, respectively, and constructed three binary SRH variables corresponding to each category.

2.3. Analytic strategy

In the descriptive analysis, we concentrated on respondents who participated in all ten waves of the survey and compared the probabilities of onset for each NCD between those with at least one type of SP at baseline and those without it. This analysis ignored the potential bias caused by the attrition of the respondents before Wave 10. Then, we estimated three Cox proportional hazards models (Model 1–3) to compute the HR for each NCD as well as functional disability and psychological distress over nine follow-up waves. In this hazards-model analysis, respondents who dropped out without any onset of NCD, functional disability, and/or psychological distress were censored in each regression model.

Model 1 estimated the crude HR for each health outcome for the SP group, unadjusted for covariates. Model 2 estimated the HR for each health outcome for the SP group, adjusted for covariates (educational attainment as well as age, household-size adjusted household spending, marital status, current smoking, heavy alcohol consumption, and SRH

Table 1
Key characteristics of the respondents at baseline.

Proportion (%)		All	Men	Women
Education				
Junior high school		17.4	17.9	17.0
High school		53.1	47.9	57.9
College or above		14.6	23.4	6.2
Others and not answered		14.9	10.8	18.8
Married		85.6	86.8	84.4
Current smoking		30.3	48.7	13.0
Heavy alcoholic drinking		4.6	8.7	0.8
Self-rated health				
Very good		7.9	8.2	7.6
Good		31.3	31.6	31.0
Somewhat good		42.0	40.8	43.2
Somewhat poor		14.1	14.6	13.6
Poor		3.7	3.7	3.7
Very poor		1.0	1.1	0.9
Non-communicable diseases				
Diabetes		7.0	9.3	4.8
Heart disease		2.6	3.6	1.8
Stroke		1.3	1.6	0.9
Hypertension		17.0	18.8	15.4
Hyperlipidemia		8.5	8.6	8.5
Cancer		1.7	1.4	2.0
Functional disability		0.8	0.8	0.9
Psychological distress		3.2	3.0	3.4
Age (years)	*M*	54.7	54.7	54.7
	SD	(2.7)	(2.7)	(2.7)
Household-size adjusted spending (monthly, thousand yen)	*M*	19.0	19.6	18.4
	SD	(19.9)	(22.6)	(16.9)
Number of respondents		33,538	16,290	17,248

at baseline). Model 3 replaced SP with the variable for the type of SP—"SP with others" or "SP alone"—in Model 2. We estimated all models for men and women separately.

However, we cannot exclude the possibility that individuals with preclinical diseases at baseline might be associated with less SP. To assess the potential bias owing to this possibility, we additionally estimated Models 1A, 2A, and 3A, in which we removed respondents who experienced the onset of each NCD in the first 1–2 years of follow-up in Models 1, 2, and 3. The numbers of respondents used in estimating these additional models were reduced by 10.1% (stroke) to 17.9% (hypertension) from the original sample.

3. Results

Key characteristics of the respondents at baseline (Wave 1) are summarized in Table 1. The prevalence of NCDs at baseline was generally limited from 0.9% (stroke among women) to 9.3% (diabetes among men), except for hypertension (18.8% among men; 15.4% among women). The prevalence of functional disability and psychological distress was also limited; it was below 1% and 4%, respectively. The prevalence of each SP is summarized in Table 2, which shows that 69.3% of the men and 71.0% of the women participated in at least one social activity at baseline. Out of the six types of SP, the category of "hobbies or cultural activities" was the most popular, followed by "exercise or sports" and "community events." About one-fifth of SP was conducted alone, and the proportion of SP alone was the highest in "exercise or sports," "support of the elderly," and "hobbies or cultural activities."

As a part of the descriptive analysis, we also compared the probabilities of the onset of each NCD between those who participated in at least one social activity at baseline and those who did not. In this analysis, we focused on those who reported no NCD at baseline and stayed in the survey through Wave 10. As shown in Table 3, we observed that, for example, among men, 16.7% of those who engaged in SP at baseline exhibited the onset of diabetes over the nine subsequent waves, as compared to 22.0% of those without SP. Further, the

Table 2
Social participation: types of activities and their prevalence at baseline.

Type of activity	Men (n = 16,290)			Women (n = 17,248)		
	With others	Alone	Total	With others	Alone	Total
Hobbies or cultural activities	5606 (34.4)[a]	2641 (16.2)	8247 (50.6)	7569 (43.9)	2230 (12.9)	9799 (56.8)
Exercise or sports	4099 (25.2)	2451 (15.0)	6550 (40.2)	3977 (23.1)	2508 (14.5)	6485 (37.6)
Community events	3826 (23.5)	178 (1.1)	4004 (24.6)	3869 (22.4)	143 (0.8)	4012 (23.3)
Support for children	476 (2.9)	78 (0.5)	554 (3.4)	628 (3.6)	133 (0.8)	761 (4.4)
Support for the elderly	287 (1.8)	132 (0.8)	419 (2.6)	567 (3.3)	323 (1.9)	890 (5.2)
Other activities	1015 (6.2)	160 (1.0)	1175 (7.2)	1212 (7.0)	197 (1.1)	1409 (8.2)
One or more activities	8754 (53.7)	2533 (15.5)	11,287 (69.3)	10,036 (58.2)	2212 (12.8)	12,248 (71.0)

[a] Numbers in parentheses indicate prevalence (%).

difference (5.3% points) was highly significant, confirming that SP had a preventive effect on diabetes among men. We observed similar results for women. We also found that SP significantly reduced the probability of onset of heart disease, stroke, hypertension, functional disability, and psychological distress for both men and women. Meanwhile, SP subdued the onset of cancer only modestly and, somewhat surprisingly, it increased the probability of onset of hyperlipidemia for both genders.

Then, we turned to the hazards-model analysis, in which the attrition was explicitly considered as a censoring factor. In Fig. 1, taking the case of diabetes as an example, we graphically compared Kaplan-Meier survival (i.e., no onset of diabetes) estimates between respondents with and without baseline SP, separately for men and women. We found that engagement in SP at baseline modestly improved the survival rate for both men and women, indicating that SP delayed the onset of diabetes.

We then conducted a regression analysis. Table 4 summarizes the results of Model 1 (for unadjusted HRs) and Model 2 (for adjusted HRs) for men, along with their modified versions, Models 1A and 2A, which removed respondents who experienced the onset of each NCD or dropped out in the first 1–2 years of follow-up. Model 1 results confirmed that SP had a preventive effect on diabetes, heart disease, stroke, and to a lesser extent, hypertension, in addition to functional disability and psychological distress, although it was not preventive of cancer or even predictive of hyperlipidemia. After controlling for baseline covariates, Model 2 results showed that SP lost its preventive effect on heart disease and hypertension. Meanwhile, Model 2A results were not much different from those of Model 2, indicating that preventive effects of SP on diabetes and stroke were robust among men.

Table 5 reports the results for women. Compared to men, the HRs of diabetes, heart disease, stroke, and hypertension were somewhat lower in Models 1 and 2. The preventive effect on hypertension remained significant, unlike with men, even after controlling for baseline covariates. The results for Model 2A showed, however, that SP was not associated with the onset of any NCD other than diabetes, suggesting its limited preventive effect. Meanwhile, as with men, the HRs were somewhat higher for NCDs than for functional disability and psychological distress.

Lastly, based on the results of Models 3 and 3A, Table 6 compares the HRs of "SP with others" and "SP alone" for the onsets of NCDs among men and women. Regarding NCDs, we focused on diabetes, stroke, and hypertension, all of which were found to be affected by SP among men and/or women. Table 6 shows that SP tended to have a more favorable impact on health outcomes when it was conducted with others than when it was engaged in alone. Notably, only "SP with others" had a significant HR for stroke, hypertension, and functional disability for both men and women. "SP with others" also had a

Table 3
Proportions (%) of the onset of non-communicable diseases, functional disabilities, and psychological distress by Wave 10.

	Number of respondents	Social participation at baseline			Difference	
		Total	Yes (A)	No (B)	(A)–(B)	95% CI[a]
Men						
Non-communicable diseases						
Diabetes	9820	18.2	16.7	22.0	−5.3	(−7.0, −3.6)
Heart disease	10,232	12.5	11.7	14.5	−2.7	(−4.2, −1.3)
Stroke	10,322	6.5	5.9	8.4	−2.5	(−3.6, −1.4)
Hypertension	9116	41.6	40.2	45.4	−5.2	(−7.4, −2.9)
Hyperlipidemia	9907	31.4	31.4	31.2	0.2	(−1.8, 2.3)
Cancer	10,532	10.5	10.1	11.7	−1.6	(−2.9, −0.2)
Functional disability	9492	3.6	3.1	5.3	−2.2	(−3.1, −1.4)
Psychological distress	9196	13.2	11.2	19.0	−7.7	(−9.3, −6.1)
Women						
Non-communicable diseases						
Diabetes	11,619	10.7	9.4	14.5	−5.1	(−6.4, −3.9)
Heart disease	11,847	7.5	7.0	8.8	−1.8	(−2.9, −0.8)
Stroke	11,891	3.9	3.5	5.2	−1.7	(−2.5, −0.9)
Hypertension	10,541	28.0	26.7	31.9	−5.2	(−7.1, −3.2)
Hyperlipidemia	11,343	30.5	31.6	27.4	4.2	(2.3, 6.1)
Cancer	11,881	8.5	8.3	9.3	−1.1	(−2.2, 0.1)
Functional disability	10,713	4.8	4.0	7.2	−3.2	(−4.1, −2.2)
Psychological distress	10,330	14.6	12.9	20.4	−7.4	(−9.0, −5.8)

[a] Confidence interval.

significant HR for diabetes and psychological distress in a more consistent manner than “SP alone” did.

4. Discussion

In the current study, using a large-scale 10-wave longitudinal dataset in Japan, we examined whether and to what extent SP prevents the onset of NCDs in comparison with that of functional disability and psychological distress among middle-aged adults.

Our hazards model regressions confirmed that SP had a modest preventive effect on the onset of selected NCDs as well as functional disability and psychological distress among middle-aged adults. The results were largely in line with observations of preceding studies that have addressed the impact of SP on health outcomes among more elderly sample (Amagasa et al., 2017; Ashida et al., 2016; Bourassa et al., 2017; Chiao et al., 2011; Fu et al., 2017; Glass et al., 1999; Hsu, 2007; James et al., 2011a, 2011b; Kanamori et al., 2014; Tomioka et al., 2017; Väänänen et al., 2009). Considering that SP is probably less constrained by health status among middle-aged adults than among elderly adults, the results of the current study using the dataset of the former age group convincingly confirmed the preventive impact of SP on health deterioration.

More specifically, three points should be noted regarding the present hazards-model regression results. First, SP prevented some but not all types of NCD. For both men and women, the onset of cancer was not associated with SP, the HR for hyperlipidemia tended to increase among women and no significant findings were observed among men. In contrast, diabetes and stroke were most effectively prevented by SP in both genders. For hypertension and heart disease, which have been the focus of preceding studies (Sundquist et al., 2004; Tu et al., 2018;

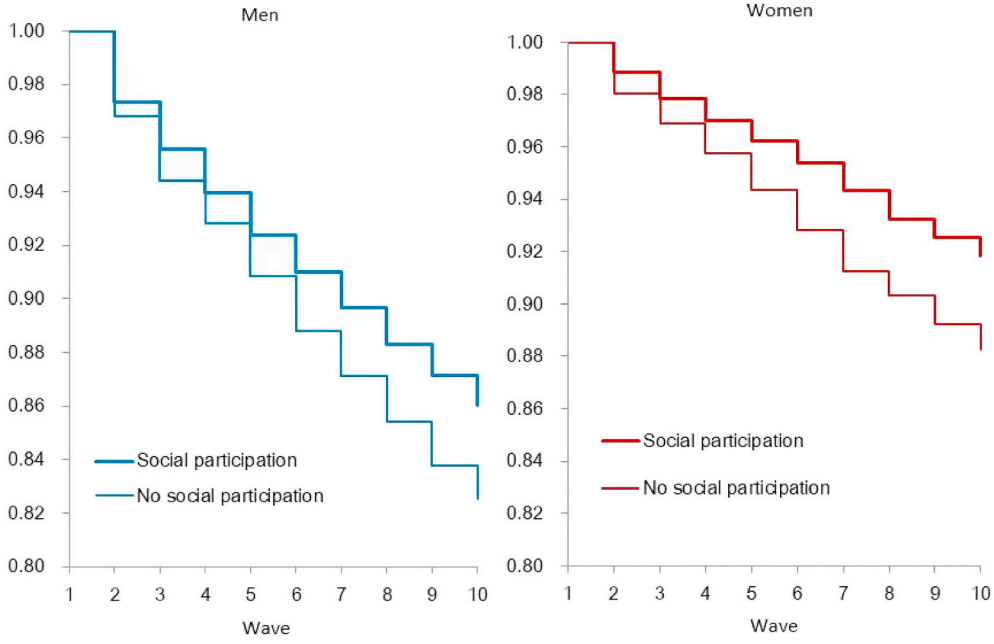

Fig. 1. Kaplan-Meier survival estimates between respondents with and without social participation at baseline: the case of diabetes.

Table 4
Estimated hazard rates of each non-communicable disease in response to social participation at baseline: men (n = 16,290).

	Model 1[a,c]		Model 2[b,c]		Model 1A[a,d]		Model 2A[b,d]	
	HR[e]	95% CI[f]	HR	95% CI	HR	95% CI	HR	95% CI
Non-communicable diseases								
Diabetes	0.79	(0.72, 0.88)	0.86	(0.77, 0.95)	0.79	(0.70, 0.90)	0.84	(0.74, 0.96)
Heart disease	0.87	(0.77, 0.99)	0.93	(0.82, 1.05)	0.89	(0.76, 1.03)	0.94	(0.81, 1.09)
Stroke	0.75	(0.64, 0.89)	0.83	(0.70, 0.99)	0.69	(0.57, 0.84)	0.77	(0.63, 0.94)
Hypertension	0.94	(0.87, 1.00)	0.95	(0.88, 1.02)	0.90	(0.82, 0.99)	0.92	(0.84, 1.01)
Hyperlipidemia	1.14	(1.05, 1.23)	1.07	(0.98, 1.16)	1.03	(0.92, 1.15)	0.98	(0.88, 1.10)
Cancer	0.93	(0.81, 1.06)	0.96	(0.84, 1.10)	0.92	(0.79, 1.07)	0.95	(0.82, 1.11)
Functional disability	0.56	(0.44, 0.71)	0.69	(0.54, 0.87)	0.58	(0.44, 0.77)	0.72	(0.54, 0.96)
Psychological distress	0.61	(0.54, 0.69)	0.67	(0.59, 0.77)	0.65	(0.57, 0.74)	0.69	(0.58, 0.83)

[a] Unadjusted for baseline covariates.
[b] Adjusted for baseline covariates.
[c] Using data of all respondents in all nine years of follow-up until the onset of each NCD or dropout.
[d] Removing data of respondents who experienced the onset of each NCD or dropped out in the first 1–2 years of follow-up.
[e] Hazard rate.
[f] Confidence interval.

Yazawa et al., 2016), we observed a modest preventive effect on hypertension only for women but no effect on heart disease.

Although identifying the reasons to account for these differences is beyond the scope of the present study, the results suggested that policy measures to support SP can prevent the onset of some major NCDs. SP, especially when accompanying interactions with others, may affect lifestyle—for example, work-life balance, leisure-time physical activity, and diet behavior—in favor of healthier choices and also help contain psychological distress, as observed in this study. These effects are likely to have preventive impact, especially on diabetes, stroke, and hypertension. Notably, preceding studies have found that these types of NCDs have close associations with psychological distress (Henderson et al., 2013; Nabi et al., 2011; Pan et al., 2011; Rotella and Mannucci, 2013), suggesting that the preventive impact of SP on them may be mediated by psychological distress. For other types of NCDs, the preventive effects of SP, if any, seem to be dominated by other factors.

Second, our sensitivity analysis suggested the possibility that individuals with preclinical diseases associated with less SP might cause the overestimation of the preventive effect of SP. We found that the observed HRs of the baseline SP declined somewhat or even became non-significant when we removed respondents who experienced the onset of NCD or dropped out in the first 1–2 years of follow-up. In this context, it is noticeable that the preventive effect of SP on diabetes was found to be robust for both men and women.

Third, the preventive impact of SP on the onset of NCDs was more limited and less consistent than the preventive impact on the onset of functional disability or psychological distress. This was probably because, compared to NCDs, functional disability and psychological distress are more directly related to the physical activities and personal interactions involved in SP. NCDs may also be affected by several factors other than SP, including dietary behaviors, health-risk factors accumulated in earlier life, and generic attributes, all of which are likely to confound the association between SP and NCDs.

In addition to these key observations, we found that the nature of social activities may affect the preventive impact of SP. Many studies have already found that the preventive impact of SP depended on the number, type, and frequency of constituent activities (Amagasa et al., 2017; Ashida et al., 2016; Hsu, 2007; Kanamori et al., 2014; Tomioka et al., 2017). The current study highlighted another key determinant of the preventive impact of SP, that is, the role of interactions with others in social activities. For stroke and hypertension as well as functional disability and psychological distress, only SP with others prevented the onset of the health problem or was more preventive than SP alone. This finding supports the view that interactions with others are a key aspect of SP that would affect later health outcomes (Levasseur et al., 2010).

4.1. Study limitations and strengths

This study had several limitations. First, as in most of previous studies, we focused on how baseline SP affected health outcomes in

Table 5
Estimated hazard rates of each non-communicable disease in response to social participation at baseline: women (n = 17,248).

	Model 1[a,c]		Model 2[b,c]		Model 1A[a,d]		Model 2A[b,d]	
	HR[e]	95% CI[f]	HR	95% CI	HR	95% CI	HR	95% CI
Non-communicable diseases								
Diabetes	0.68	(0.60, 0.76)	0.75	(0.66, 0.85)	0.67	(0.58, 0.78)	0.74	(0.64, 0.86)
Heart disease	0.85	(0.73, 0.99)	0.92	(0.79, 1.07)	0.80	(0.67, 0.95)	0.87	(0.73, 1.04)
Stroke	0.70	(0.58, 0.86)	0.78	(0.64, 0.97)	0.79	(0.62, 1.01)	0.91	(0.71, 1.16)
Hypertension	0.88	(0.81, 0.95)	0.91	(0.84, 0.99)	0.92	(0.83, 1.01)	0.94	(0.84, 1.04)
Hyperlipidemia	1.30	(1.20, 1.41)	1.27	(1.17, 1.38)	1.30	(1.17, 1.44)	1.27	(1.14, 1.41)
Cancer	0.94	(0.81, 1.08)	0.96	(0.83, 1.11)	0.88	(0.75, 1.03)	0.89	(0.76, 1.05)
Functional disability	0.60	(0.49, 0.73)	0.71	(0.58, 0.87)	0.63	(0.50, 0.80)	0.73	(0.58, 0.94)
Psychological distress	0.65	(0.58, 0.73)	0.73	(0.65, 0.82)	0.64	(0.55, 0.75)	0.67	(0.57, 0.78)

[a] Unadjusted for baseline covariates.
[b] Adjusted for baseline covariates.
[c] Using data of all respondents in all nine years of follow-up until the onset of each NCD or dropout.
[d] Removing data of respondents who experienced the onset of each NCD or dropped out in the first 1–2 years of follow-up.
[e] Hazard rate.
[f] Confidence interval.

Table 6
Estimated hazard rates of each non-communicable disease in response to two types of social participation at baseline[a].

Onset	Social participation	Men				Women			
		Model 3[b]		Model 3A[c]		Model 3[b]		Model 3A[c]	
		HR[d]	95% CI[e]	HR	95% CI	HR	95% CI	HR	95% CI
Non-communicable diseases									
Diabetes	With others	0.87	(0.78, 0.97)	0.86	(0.75, 0.98)	0.73	(0.64, 0.83)	0.74	(0.63, 0.86)
	Alone	0.81	(0.70, 0.94)	0.80	(0.66, 0.97)	0.85	(0.71, 1.03)	0.78	(0.62, 0.98)
Stroke	With others	0.79	(0.66, 0.94)	0.76	(0.62, 0.94)	0.77	(0.62, 0.95)	0.88	(0.68, 1.14)
	Alone	0.99	(0.78, 1.25)	0.79	(0.59, 1.06)	0.87	(0.63, 1.19)	1.04	(0.72, 1.49)
Hypertension	With others	0.96	(0.84, 1.04)	0.92	(0.83, 1.01)	0.91	(0.83, 0.99)	0.93	(0.83, 1.03)
	Alone	0.93	(0.85, 1.04)	0.92	(0.81, 1.05)	0.94	(0.83, 1.06)	0.98	(0.84, 1.14)
Functional disability	With others	0.62	(0.48, 0.80)	0.66	(0.49, 0.90)	0.68	(0.55, 0.84)	0.71	(0.56, 0.92)
	Alone	0.90	(0.66, 1.24)	0.90	(0.61, 1.33)	0.86	(0.64, 1.17)	0.83	(0.58, 1.20)
Psychological distress	With others	0.65	(0.57, 0.74)	0.68	(0.57, 0.81)	0.69	(0.61, 0.78)	0.68	(0.58, 0.79)
	Alone	0.76	(0.64, 0.91)	0.76	(0.60, 0.96)	0.89	(0.75, 1.06)	0.78	(0.58, 0.79)

[a] Adjusted for covariates at baseline.
[b] Using data of all respondents ill all nine years of follow-up (until the onset of each NCD or censored).
[c] Removing data of respondents who experienced the onset of each NCD or dropped out in the first 1–2 years of follow-up.
[d] Hazard rate.
[e] Confidence interval.

follow-up years, which led us to disregard the subsequent evolution of SP and its impact on health outcomes. The survey started with individuals aged 50–59 years, a substantial portion of whom are likely to have experienced retirement and other major life events, which may have affected both SP and health outcomes. In addition, we could not exclude the possibility that the baseline SP was affected by the health status at that time as well as other individual attributes of the respondents, which may have led to biased estimates of the preventive impact of SP. This possibility was highlighted by the sensitivity analysis. Finally, we should be cautious while generalizing these results because contextual/institutional background factors may affect the association between SP and health (Sirven and Debrand, 2008).

Despite these limitations, we believe that the present findings provide new insights into the understanding of the relevance of SP to health. Most notably, this study uncovered the preventive impact of SP on selected NCDs among middle-aged adults, unlike previous studies, which have mostly focused on functional disability, psychological distress, and mortality among more elderly adults.

5. Conclusions

The results of this study underscored that SP can prevent the onset of selected NCDs, suggesting that policy measures to encourage SP are favorable for the health of middle-aged adults. To enhance the effectiveness of interventions to enhance SP among adults, the present results suggest the need to encourage personal interactions with other individuals during SP.

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Conflicts of interest

None.

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