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Social participation and the onset of functional disability by socioeconomic status and activity type: The JAGES cohort study

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ABSTRACT

The impact of social participation on older adults' health may differ by individual socioeconomic status (SES). Consequently, we examined SES effect modification on the associations between types of social activity participation and incident functional disability. Cohort data from the 2003 Japan Gerontological Evaluation Study (JAGES) was utilized. This included individuals who were aged 65 or older and functionally independent at baseline. Analysis was carried out on 12,991 respondents after acquisition of information about their long-term care (LTC) status in Japan. Incident functional disability was defined based on medical certification and LTC information was obtained from municipal insurance databases. Cox proportional hazard regression was conducted for analysis. Results indicated that participants in a sport (hazard ratio [HR]: 0.66; 95% confidence interval [CI]: 0.51, 0.85) or hobby group (HR: 0.69; 95% CI: 0.55, 0.87), or who had a group facilitator role (HR: 0.82; 95% CI: 0.66, 1.02) were less likely to be disabled. While men with 13 or more years of education were less likely to become disabled if they held facilitator roles, this association was weak among men with 0–5 years of education (HR of interaction term between 0 and 5 years of education and facilitator role dummy variable = 3.95; 95% CI: 1.30, 12.05). In conclusion, the association between group participation and smaller risk of the functional disability was stronger among highly educated older adults. Intervention programs promoting social participation should consider participants' socioeconomic backgrounds.

1. Introduction

The Japanese population is aging at an unprecedented rate, and the ratio of older adults is expected to reach 30.3% in 2025 and 39.9% in 2060. Accordingly, medical and nursing care costs have increased by 1.4 times in the 12-year period from 2000 to 2012 (Ministry of Health, Labour and Welfare, 2000a; Ministry of Health, Labour and Welfare, 2012b; Ministry of Health, Labour and Welfare, 2012a). Therefore, disease prevention and the need for long-term care are the pressing issues in healthcare system sustainability.

Social participation has been reported to be an important factor for sustaining older adults' physical and cognitive functions. Many studies have shown social participation to have positive effects on the health of older populations such as preserving physical function and preventing dementia as well as reducing the risk of depression, cardiovascular diseases, and mortality (Aida et al., 2011; Buchman et al., 2009; Glass et al., 1999; Hsu, 2007; Iwasaki et al., 2002; Väänänen et al., 2009). It is also suggested that promoting social participation could reduce healthcare costs (Yoshida et al., 2007).

Existing studies have estimated an overall association between social participation and maintaining functioning among older adults. However, it is plausible that these associations vary across individual socioeconomic status (SES) backgrounds. Specifically, socioeconomic status (SES) is a strong determinant of daily life behaviors, including individuals' social participation types and personal relationships as well as an important modifier of the association between social participation and health (Moore, 1990). Studies from the behavioral sciences consistently suggest that psychological stress due to poor SES may affect behavior choices. Perceptions of stress in relationships with other group members and the types of individuals that are easier to interact with may also differ between individuals' with different SESs (Aida, 2010; Sisson, 2007). However, few studies have investigated how the group or participation types vary according to SES and how SES differences affect the association between social participation and health status.

In this study, we used data from a large-scale survey of Japanese older adults and examined the effect modification of individual SES on

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the associations between participation in various social activities, participation types, and the future onset of long-term care (LTC) need.

2. Materials and methods

2.1. Data

This study used the data from the JAGES cohort. A detailed description of the study protocol is available elsewhere (Nishi et al., 2011). Briefly, a baseline survey was conducted in October 2003 in six municipalities in the Aichi prefecture, Japan. In two of six municipalities, 5000 people were randomly selected. All eligible residents were investigated for the other municipalities. Questionnaires were mailed to 28,152 non-institutionalized functionally independent individuals aged 65 or older. Functional independence was defined as not receiving benefits from public LTC insurance. All individuals aged 65 years old or over are eligible to the insurance program regardless of their income statuses (Tsutsui and Muramatsu, 2007). A total of 14,804 respondents returned the questionnaire (response rate = 52.6%). We excluded 1813 respondents for the following reasons: 45 had invalid identification on health records; 1386 died, were functionally dependent, or had cognitive impairment at baseline; 16 were aged 64 or younger; and 366 of which we found inconsistent information about age and gender between baseline survey data and another data for gathering outcome information. Thus, we used data from a total of 12,991 respondents (men: 6345 men, women: 6646).

2.2. Ethical considerations

The study protocol for the JAGES project was approved by the Nihon Fukushi University Ethics Committee. Additionally, data use for this study was approved by the University of Tokyo Institutional Review Board (No. 10555).

2.3. Measurements

2.3.1. Functional disability

Participants were followed up in regard to their incident functional disability for 4 years (1461 days). Information on incident functional disability was obtained from municipal public LTC insurance system

Table 1
Incidence rates (1000 person-years) of functional disability by subjects' characteristics based on data from the Japan Aichi Gerontological Evaluation Study (JAGES).

	Men			Women		
	n (%)	Incidence rate	(95% CI)	n (%)	Incidence rate	(95% CI)
Age(years)						
65–69	2472 (40.0)	9.7	(7.9, 11.9)	2273(34.2)	8.4	(6.7, 10.5)
70–74	1938 (30.5)	16.6	(14.1, 20.0)	1860(28.0)	20.7	(17.7, 24.4)
75–79	1237 (19.5)	40.9	(35.4, 47.2)	1474(22.2)	49.1	(43.6, 55.4)
80+	698 (11.0)	94.1	(82.51 07.4)	1039(15.6)	125.8	(114.2 138.5)
Marital status						
Married	5287 (83.3)	43.7	(20.7, 24.9)	3401(51.2)	22.4	(20.0, 25.2)
Widowed/divorced	589 (9.3)	53.3	(44.3, 64.1)	2603(39.2)	54.1	(49.6, 59.0)
Single	36 (0.57)	22.3	(7.2, 69.2)	184 (2.8)	47.2	(33.6, 66.7)
Other/missing	433 (6.8)	33.0	(25.3, 43.0)	458 (6.9)	41.5	(32.9, 52.4)
Medical condition(3 major diseases[a])						
Yes	1348 (21.3)	34.9	(30.1, 40.4)	948 (14.3)	59.6	(52.0, 68.4)
No	4997 (78.8)	23.7	(21.6, 26.0)	5698(85.7)	32.7	(30.4, 35.2)
Employment status						
Yes	2048 (32.3)	12.0	(9.8, 14.6)	1169(17.6)	16.5	(13.2, 20.7)
No	4188 (66.0)	32.9	(30.2, 35.9)	5325(80.1)	40.5	(37.8, 43.4)
Missing	109 (1.7)	34.2	(20.3, 57.7)	152 (2.30)	51.9	(36.0, 74.6)
Equivalized income(million yen)						
< 1.99	2192 (34.6)	26.4	(23.1, 30.1)	2115(31.8)	35.7	(31.7, 40.0)
2.00–3.99	2725 (43.0)	22.2	(19.5, 25.2)	1992(30.0)	25.3	(22.0, 29.2)
4.00+	649 (10.2)	20.0	(15.2, 26.4)	575 (8.7)	35.5	(28.3, 44.4)
Missing	779 (12.3)	44.1	(37.1, 52.5)	1964(30)	49.1	(44.2, 54.5)
Educational attainment(years)						
Very low(≦5)	143 (2.3)	63.9	(45.2, 90.3)	399 (6.0)	93.7	(78.71 11.7)
Low(6–9)	3230 (50.9)	29.9	(27.0, 33.1)	3604(54.2)	32.4	(29.5, 35.5)
Middle(10–12)	1709 (26.9)	20.3	(17.2, 24.1)	1921(28.9)	31.7	(27.8, 36.1)
High(≧13)	874 (13.8)	17.4	(13.5, 22.5)	328 (4.9)	30.0	(21.7, 41.3)
Other/missing	389 (6.1)	26.3	(19.2, 36.0)	394 (5.9)	50.5	(40.1, 63.5)
Participation in group activities						
Sports group or club						
Yes	1251(22.3)	13.7	(10.8, 17.4)	1127(19.9)	13.9	(10.8, 17.8)
No	4351(77.7)	27.2	(24.8, 29.9)	4537(80.1)	39.1	(36.2, 42.2)
Hobby group						
Yes	1549(27.4)	16.3	(13.4, 19.8)	2016(35.1)	19.9	(17.0, 23.3)
No	4096(72.6)	26.6	(24.1, 29.3)	3728(64.9)	42.0	(38.7, 45.6)
Volunteer group						
Yes	623(11.1)	14.5	(10.4, 20.2)	563(9.9)	18.0	(13.1, 24.6)
No	5001(88.9)	25.1	(22.9, 27.4)	5139(90.1)	35.7	(33.1, 38.5)
Facilitator role						
Yes	2073(46.0)	15.8	(13.3, 18.8)	1340(30.7)	18.3	(15.0, 22.4)
No	2430(54.0)	27.6	(24.4, 31.2)	3023(69.3)	37.6	(34.2, 41.3)
The number of participating groups(range:0–3)						
0	3324(60.9)	28.4	(25.6, 31.4)	3282(60.3)	44.8	(41.2, 48.8)
1	1294(23.7)	22.5	(18.7, 27.1)	1233(22.7)	22.6	(18.7, 27.3)
2	674(12.3)	10.6	(7.3, 15.3)	707(13.0)	11.2	(7.9, 15.9)
3	168(3.1)	3.0	(0.7, 12.0)	218(4.0)	14.1	(8.0, 24.8)

CI: confidence interval.
[a] The three major diseases include cancer, heart disease, and stroke.

databases. Those who were newly certified as eligible for the LTC insurance benefit were considered to be functionally disabled. The certification of eligibility for the LTC insurance benefit is judged based on a nationally standardized procedure including a physician's examination and evaluation of physical and cognitive functions.

2.3.2. Social participation

Group participation was evaluated by asking the question, "Do you belong to any of the following groups or organizations?" to which respondents answered "yes" or "no." Social participation was classified into the following eight types: (1) sports groups or clubs; (2) hobby groups; (3) volunteer groups; (4) citizen/consumer groups; (5) religious organizations; (6) political groups/organizations; (7) local community activities (including neighborhood associations, senior citizen clubs, or firefighting teams); and (8) industry or trade associations. In this study, we primarily focused on the three groups/organizations previously identified as being associated with lower risks for functional disabilities. Specifically, this included sports groups (Kanamori et al., 2012), hobby groups (Takeda et al., 2010), and volunteer groups (Li and Ferraro, 2005; Lum and Lightfoot, 2005; Musick and Wilson, 2003). Our preliminary analysis found that participations to other groups/organizations did not associate with incident functional disability. The questionnaire also asked if respondents had a facilitator role in any group or organization in which they participated using the question, "Do you hold the position of president, facilitator, treasurer, or other executive in any of the groups/organizations?"

2.3.3. Socioeconomic status

Although SES can be evaluated using various indicators (primarily resulting from data availability), in this study our proxy measures for SES were income and educational attainment (Adler and Ostrove, 1999). First, we calculated equivalized annual household income (i.e., annual household income divided by the square root of the number of family members). Similar to recent studies using Japan Gerontological Evaluation study (JAGES) data (Hikichi et al., 2015), we then divided income into four groups: low (less than 2 million yen), middle (2–3.99 million yen), and high (4 million yen or higher). Educational attainment was evaluated as self-reported years of formal education, and was categorized as: very low (less than 6 years), low (6–9 years), middle (10–12 years), and high (13 years or over).

2.3.4. Covariates

Consistent with previous studies, (Kanamori et al., 2014; Liao et al., 2011) age, marital status, employment status, and self-reported medical condition for three major diseases (cancer, heart disease, and stroke) were used as covariates. Municipality dummy variables were also adjusted to account for unobserved characteristics of municipalities (e.g., public services, natural environment, traffic systems that could contribute to LTC prevention). Marital status was divided into "married," "widowed/divorced," "single," and "other." Employment was determined by responding "yes" to the question, "Do you currently have a job that provides income?"

2.4. Statistical analysis

A Cox proportional hazards model was used to separately evaluate the associations between social participation and incident functional disability for men and women. To estimate the effect modification of the various types of social participation and SES, interaction terms were created using participation in each group or organization type with each equivalized household income group and educational attainment category. In addition, to confirm robustness, we conducted multiple sensitivity analyses based on the utilization of the number of participating groups as exposure variables rather than the participation

Table 2

Hazard ratios for incident functional disability (95% confidence intervals) by participation in sports group activities: results of Cox regression analysis.

Men	Model 1	Model 2	Model 3
Participation in sports group activities	0.66(0.51, 0.85)	0.43(0.19, 1.02)	0.39(0.17, 0.93)
×Education very low		5.61(1.59, 19.82)	
×Education low		1.74(0.70, 4.35)	
×Education middle		0.93(0.33, 2.59)	
×Education high		1.00(ref)	
×Income low			2.14(0.82, 5.59)
×Income middle			1.26(0.48, 3.31)
×Income high			1.00(ref)
Income low (<1.99)	1.11(0.79, 1.56)	1.09(0.78, 1.54)	0.98(0.68, 1.42)
Income middle (2.00–3.99)	0.92(0.66, 1.28)	0.90(0.65, 1.26)	0.87(0.61, 1.24)
Income high (4.00+)	1.00(ref)	1.00(ref)	1.00(ref)
Education very low (≦5)	1.89(1.15, 3.09)	1.49(0.86, 2.57)	1.85(1.13, 3.04)
Education low (6–9)	1.27(0.94, 1.71)	1.19(0.87, 1.63)	1.27(0.94, 1.7)
Education middle (10–12)	1.22(0.89, 1.69)	1.24(0.88, 1.74)	1.22(0.89, 1.69)
Education high (≧13)	1.00(ref)	1.00(ref)	1.00(ref)
Women	Model 1	Model 2	Model 3
Participation in sports group activities	0.58(0.44, 0.76)	0.34(0.10, 1.14)	0.34(0.12, 0.93)
×Education very low		0.98(0.16, 6.18)	
×Education low		1.47(0.42, 5.17)	
×Education middle		2.03(0.57, 7.2)	
×Education high		1.00(ref)	
×Income low			1.72(0.57, 5.23)
×Income middle			1.08(0.33, 3.47)
×Income high			1.00(ref)
Income low (<1.99)	1.24(0.94, 1.63)	1.24(0.94, 1.63)	1.19(0.9, 1.58)
Income middle (2.00–3.99)	1.02(0.77, 1.35)	1.02(0.77, 1.36)	1.02(0.76, 1.36)
Income high (4.00+)	1.00(ref)	1.00(ref)	1.00(ref)
Education very-low (≦5)	0.95(0.63, 1.44)	0.90(0.59, 1.39)	0.94(0.62, 1.42)
Education low (6–9)	0.75(0.52, 1.10)	0.71(0.48, 1.06)	0.73(0.51, 1.07)
Education middle (10–12)	0.70(0.48, 1.03)	0.65(0.43, 0.97)	0.69(0.47, 1.01)
Education high (≧13)	1.00(ref)	1.00(ref)	1.00(ref)

Adjusted for age, marital status, employment status, the three major diseases (cancer, heart disease, and stroke), and municipality.
Income (million yen) denotes annual equivalized household income.
Units: education = years, income = million yen.

Table 3
Hazard ratios for incident functional disability (95% confidence intervals) by participation in hobby group activities: results of Cox regression analysis.

Men	Model 1	Model 2	Model 3
Participation in hobby group activities	0.69 (0.55,0.87)	0.56 (0.30,1.05)	0.62 (0.31,1.23)
×Education very low		3.97 (1.13,14.02)	
×Education low		1.41 (0.70,2.82)	
×Education middle		0.87 (0.40,1.90)	
×Education high		1.00(ref)	
×Income low			1.38 (0.63,3.02)
×Income middle			1.03 (0.47,2.22)
×Income high			1.00 (ref)
Income low (<1.99)	1.09 (0.77,1.54)	1.09 (0.77,1.54)	1.02 (0.69,1.51)
Income middle (2.00–3.99)	0.92 (0.65,1.29)	0.91 (0.65,1.27)	0.91 (0.61,1.34)
Income high (4.00+)	1.00(ref)	1.00(ref)	1.00(ref)
Education very low (≦5)	1.71 (1.02,2.84)	1.43 (0.81,2.50)	1.72 (1.03,2.87)
Education low (6–9)	1.29 (0.95,1.74)	1.19 (0.85,1.67)	1.28 (0.95,1.73)
Education middle (10–12)	1.19 (0.86,1.65)	1.21 (0.84,1.75)	1.19 (0.86,1.64)
Education high (≧13)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Women	Model 1	Model 2	Model 3
Participation in hobby group activities	0.67 (0.55,0.80)	0.64 (0.31,1.33)	0.51 (0.28,0.92)
×Education very low		1.02 (0.35,2.95)	
×Education low		1.15 (0.53,2.49)	
×Education middle		0.89 (0.40,1.97)	
×Education high		1.00(ref)	
×Income low			1.16 (0.59,2.27)
×Income middle			1.08 (0.54,2.14)
×Income high			1.00(ref)
Income low (<1.99)	1.22 (0.93,1.61)	1.23 (0.94,1.61)	1.18 (0.87,1.59)
Income middle (2.00–3.99)	1.01 (0.77,1.34)	1.01 (0.77,1.34)	1.00 (0.73,1.36)
Income high (4.00+)	1.00(ref)	1.00(ref)	1.00(ref)
Education very low (≦5)	0.95 (0.63,1.45)	0.94 (0.56,1.56)	0.96 (0.63,1.46)
Education low (6–9)	0.77 (0.52,1.12)	0.74 (0.46,1.19)	0.76 (0.52,1.11)
Education middle (10–12)	0.76 (0.52,1.12)	0.78 (0.48,1.28)	0.75 (0.51,1.10)
Education high (≧13)	1.00(ref)	1.00(ref)	1.00(ref)

Adjusted for age, marital status, employment status, the three major diseases (cancer, heart disease, and stroke), and municipality.
Income (million yen) denotes annual equivalized household income.
Units: education = years, income = million yen.

Table 4
Hazard ratios for incident functional disability (95% confidence intervals) by having a facilitator role in a group: results of Cox regression analysis.

Men	Model 1	Model 2	Model 3
Have facilitator role	0.82 (0.66,1.02)	0.76 (0.41,1.44)	0.39 (0.18,0.87)
×Education very low		3.95 (1.30,12.05)	
×Education low		1.09 (0.54,2.17)	
×Education middle		0.60 (0.27,1.33)	
×Education high		1.00 (ref)	
×Income low			2.33 (0.97,5.63)
×Income middle			1.72 (0.72,4.10)
×Income high			1.00 (ref)
Income low (<1.99)	1.09 (0.73,1.62)	1.08 (0.72,1.60)	0.82 (0.52,1.31)
Income middle (2.00–3.99)	0.99 (0.68,1.46)	0.99 (0.67,1.46)	0.84 (0.54,1.31)
Income high (4.00+)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Education very low (≦5)	2.17 (1.22,3.84)	1.36 (0.64,2.91)	2.14 (1.21,3.78)
Education low (6–9)	1.40 (1.00,1.97)	1.36 (0.88,2.09)	1.39 (0.99,1.96)
Education middle (10–12)	1.16 (0.79,1.68)	1.37 (0.86,2.20)	1.15 (0.79,1.68)
Education high (≧13)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Women	Model 1	Model 2	Model 3
Have facilitator role	0.70 (0.56,0.88)	0.30 (0.10,0.87)	0.45(0.20, 1.00)
×Education very low		3.13 (0.86,11.34)	
×Education low		2.22 (0.73,6.81)	
× Education middle		2.69 (0.86,8.42)	
× Education high		1.00 (ref)	
× Income low			1.56(0.64, 3.79)
× Income middle			1.46(0.59, 3.63)
× Income high			1.00(ref)
Income low (<1.99)	1.15 (0.84,1.58)	1.14 (0.83,1.57)	1.08(0.76, 1.52)
Income middle (2.00–3.99)	0.97(0.70,1.34)	0.96 (0.69,1.32)	0.92(0.65, 1.30)
Income high (4.00+)	1.00 (ref)	1.00 (ref)	1.00 (ref)
Education very low (≦5)	0.66 (0.41,1.08)	0.52 (0.31,0.89)	0.65 (0.40,1.06)
Education low (6–9)	0.63 (0.41,0.96)	0.52 (0.33,0.83)	0.62 (0.41,0.95)
Education middle (10–12)	0.57 (0.37,0.87)	0.45 (0.28,0.73)	0.55 (0.36,0.85)
Education high (≧13)	1.00 (ref)	1.00(ref)	1.00 (ref)

Adjusted for age, marital status, employment status, the three major diseases (cancer, heart disease, and stroke), and municipality.
Income (million yen) denotes annual equivalized household income.
Units: education = years, income = million yen.

to each group. We additionally conducted those analysis using alternative specifications of socioeconomic indicators: education length and income as continuous or ordinal variables. For all explanatory variables, following recent statistical suggestion (White and Thompson, 2005), missing information was modeled as dummy variables.

3. Results

Respondents' mean age was 72.9 years (men: 72.3 years, women: 73.3 years). Participation proportions were similar for both men and women, with the highest proportion for local community activities (men: 57.6%, women: 58.4%), followed by hobby groups (men: 27.45%, women: 35.1%), and sports clubs (men: 22.3%, women: 19.9%). Of those that engaged in social participation, 46.0% men and 30.7% women had facilitator roles. For both genders, participation in volunteer, sports, or hobby groups tended to increase with higher educational attainment. Among women, social participation tended to be highest in the middle-income group (Table 1, Supplementary Tables 1 and 2).

After adjusting for age, marital status, employment status, household income, educational attainment, and illnesses, the risk of incident functional disability among men was lower with participation in a sports group (Hazard Ratio [HR] = 0.66; 95% confidence interval [CI]: 0.51, 0.85) (Table 2, Model 1); hobby group (HR = 0.69; 95% CI: 0.55, 0.87) (Table 3, Model 1); and having a facilitator role (HR = 0.82; 95% CI: 0.66, 1.02) (Table 4, Model 1). Among women, the risk of functional disability was lower for those who participated in a sport or hobby group, and the risk of incident functional disability was lower among those with facilitator roles.

Regarding the effect modification by SES among men, compared to the reference (highest education men who did not participate in sports groups, men who were least educated and participated in sports groups have been by 5.61 (95% CI: 1.59, 19.82) times more likely to develop functional disability. (Table 2, model 2). Here, the modification estimate of participating hobby group was 3.97 (95% CI: 1.13, 14.02) (Table 3, Model 2). The effect modifications were not clearly observed among women and the modification by income levels. Analysis of volunteer activities produced different results. Although the statistical evidence was weak, the association between volunteer group participation and incident functional disability was 3.74 times smaller (95% CI: 0.81, 17.23) for those with higher than lower income (Table 5, Model 3). With respect to having a group facilitator role, increased years of education resulted in lower risks for incident functional disability among both men and women. The risk was lower than those with high education by 3.95 (95% CI: 1.30, 12.05) times among men and 3.13 (95% CI: 0.86, 11.34) times among women (Table 4, Model 2), respectively. In terms of income level, The hazard rations were 2.33 (95% CI: 0.97, 5.63) for men and 1.56 (95% CI: 0.64, 3.79) for women (Table 4, Model 3). These trends were observed in the plot of predicted hazards (Figs. 1 and 2).

The results of our sensitivity analyses using the number of participating groups as the exposure variable rather than the participation for each activity showed the similar trends. For example, compared to the highly educated men, men in the "very low" category in educational attainment were by 1.47 times more likely to be disabled per 1 standard deviation unit increase in the number of participation groups (Supplementary Tables 3 and 4, Model 2). These trends were similarly observed in the predicted hazard ratios reflecting both main and modification

Table 5
Hazard ratios for incident functional disability (95% confidence intervals) by participation in volunteer group activities: results of Cox regression analysis.

Men	Model 1	Model 2	Model 3
Participation in volunteer group activities	0.81 (0.57,1.15)	0.88(0.38,2.07)	0.27 (0.07,1.13)
× Education very low		–[a]	
× Education low		1.09(0.41,2.88)	
× Education middle		0.55(0.18,1.68)	
× Education high		1.00 (ref)	
× Income low			3.74 (0.81,17.23)
× Income middle			2.47 (0.54,11.40)
× Income high			1.00 (ref)
Income low (<1.99)	1.12 (0.80,1.58)	1.13(0.80,1.58)	1.01 (0.72,1.43)
Income middle (2.00–3.99)	0.91 (0.65,1.27)	0.91(0.65,1.28)	0.85 (0.60,1.19)
Income high (4.00+)	1.00 (ref)	1.00(ref)	1.00(ref)
Education very low (≦5)	1.75 (1.06,2.91)	1.79(1.07,2.99)	1.76(1.06, 2.91)
Education low (6–9)	1.26 (0.94,1.69)	1.26(0.92,1.71)	1.25(0.93, 1.68)
Education middle (10–12)	1.17 (0.85,1.61)	1.23(0.88,1.72)	1.17(0.85, 1.61)
Education high (≧13)	1.00 (ref)	1.00 (ref)	1.00(ref)
Women	Model 1	Model 2	Model 3
Participation in volunteer group activities	0.86(0.62, 1.19)	0.94(0.36,2.44)	0.81(0.29,2.23)
×Education very low		0.57(0.06,5.17)	
×Education low		0.72(0.24,2.18)	
×Education middle		0.99(0.33,2.94)	
×Education high		1.00 (ref)	
×Income low			0.68 (0.20,2.31)
×Income middle			1.13 (0.35,3.65)
×Income high			1.00 (ref)
Income low (<1.99)	1.22(0.93, 1.59)	1.23(0.94,1.62)	1.24 (0.94,1.63)
Income middle (2.00–3.99)	0.99(0.75, 1.30)	1.00(0.75,1.32)	0.98 (0.73,1.30)
Income high (4.00+)	1.00(ref)	1.00 (ref)	1.00 (ref)
Education very low (≦5)	0.97(0.64, 1.46)	0.99(0.64,1.52)	0.98 (0.65,1.48)
Education low (6–9)	0.76(0.52, 1.10)	0.77(0.52,1.15)	0.76 (0.53,1.10)
Education middle (10–12)	0.71(0.49, 1.04)	0.72(0.48,1.08)	0.71 (0.49,1.05)
Education high (≧13)	1.00(ref)	1.00 (ref)	1.00 (ref)

Adjusted for age, marital status, employment status, the three major diseases (cancer, heart disease, and stroke), and municipality.
Income (million yen) denotes annual equivalized household income.
Units: education = years, income = million yen.
[a] Values could not be estimated because there were too few cases.

effects (Supplementary Figs. 1 and 2). Further sensitivity analyses using alternative specifications of income and educations showed almost the same results (Supplementary Table 5).

4. Discussion

The results of our study showed that more years of education and higher incomes were associated with increased participation in sports, hobby, and volunteer groups for men. In contrast, no consistent associations were observed for women. Similar to previous studies (Kanamori et al., 2012; Takeda et al., 2010), participation in social activities such as sports or hobby was associated with a lower risk of functional disability. Among men, this association between participation in groups/organizations and lower risk of incident functional disability was potentially enhanced by having more years of education. Although these potential effect modifications were not clearly observed among women, the negative association between having a facilitator role in a group and risk of functional decline was enhanced among the highly educated.

Although we did not find evidence to directly support the mechanisms for these findings, group participation requires a high level of member interaction and strategic team play is occasionally required (especially in the case of sports groups). Another possible explanation for the SES effect modification among men is that group characteristics may vary by SES, even within the same group category (e.g., sports). Specifically, groups selected by those with a higher SES may have a higher level of activity or aspects that produce better health protection effects (Socialist Health Association, 1980). Further studies are required to determine if members' group participation characteristics vary according to their SES.

We also found that having a group facilitator role is more favorable in terms of maintaining functional ability for men with a high SES. This may be explained by the fact that taking on a group leadership role requires special skills, management capabilities, and rich human capital (e.g., non-cognitive skills such as self-esteem and extraversion) (Heckman et al., 2006; Heckman and Kautz, 2013).

However, analysis of women's data did not clearly show the SES modification trends in the association between group participation and disability. This may reflect a smaller health disparity among Japanese women (Kagamimori et al., 2009). Alternatively, as indicated in previous JAGES-related studies, the current SES measure may inappropriately gauge the actual social status of older Japanese women (Kagamimori et al., 2009; Kondo et al., 2009). There are likely other factors that may help explain why the associations were not as marked among women than men. For example, men and women may differ in where and how they seek social support. If women are more likely to have informal social networks (via friends, family members), then the impact of reduced social isolation and/or greater social support from participation in social groups may be less among women than upon men who may rely on such groups for forming or maintaining their social networks (Antonucci and Akiyama, 1987; Berkman et al., 2000).

This study has a number of strengths, particularly in its analysis of a large sample of cohort data and provision of rich information about a variety of social activities and SES. However, when interpreting findings it should be noted that all variables were based on self-report, which may have resulted in some degree of reporting bias. For example, it is highly likely that responses pertaining to hobby group participation were specifically made in regard to activities held at a community center or other local venue. In other words, respondents may not recognize that private groups of friends getting together for a similar purpose could be classified as "participation in an organization." Thus, in this case, they may have responded "no" to the question about hobby group participation. In addition, set factors such as selection of whether or not respondents partake in social participation and what groups/organizations they participate in may be affected by individuals' personalities, preferences, or cultural backgrounds. Based on the limited data, it cannot be determined if this acts as confounders on SES factors. Another limitation is that this study only observed the relationship between SES at baseline and later functional disability. In our data, recoveries from functionally disabled statuses were not captured, potentially leading to underestimations of the results. We could not find the statistics on how many people recovered from the disabled status among Japanese older population. In addition, socioeconomically vulnerable respondents were less likely to participate in our study and they were likely to be disabled early. This could cause underestimations of our findings. To eliminate the possibility of selection bias, further studies are needed to examine the processes (e.g., life course) leading up to the outcome.

National and local governments are undertaking various measures to promote social participation in order to revitalize communities, generate motivation, and prevent the need for LTC. Recent reports indicate that older adults are gradually becoming more interested in social participation While only 47.9% responded that they wanted to participate in social activities in 1998, this rate increases to 54.1% in 2008. Specifically, in 2008, 70% of older adults expressed a desire to participate in group activities, responding with "yes" to the statements "I want to participate" or "I want to participate but am unable to based on my circumstances" (Cabinet Office, Government of Japan, 2012). Although numerous studies have indicated that social participation has health benefits (Ichida et al., 2013; Kanamori et al., 2012), the results of this study suggest that the types of activities that an individual participates in may vary with their SES as a result of behavioral determinants that affect participation motivation. Nonetheless, the findings of this study should not be interpreted to signify that older adults with low SES

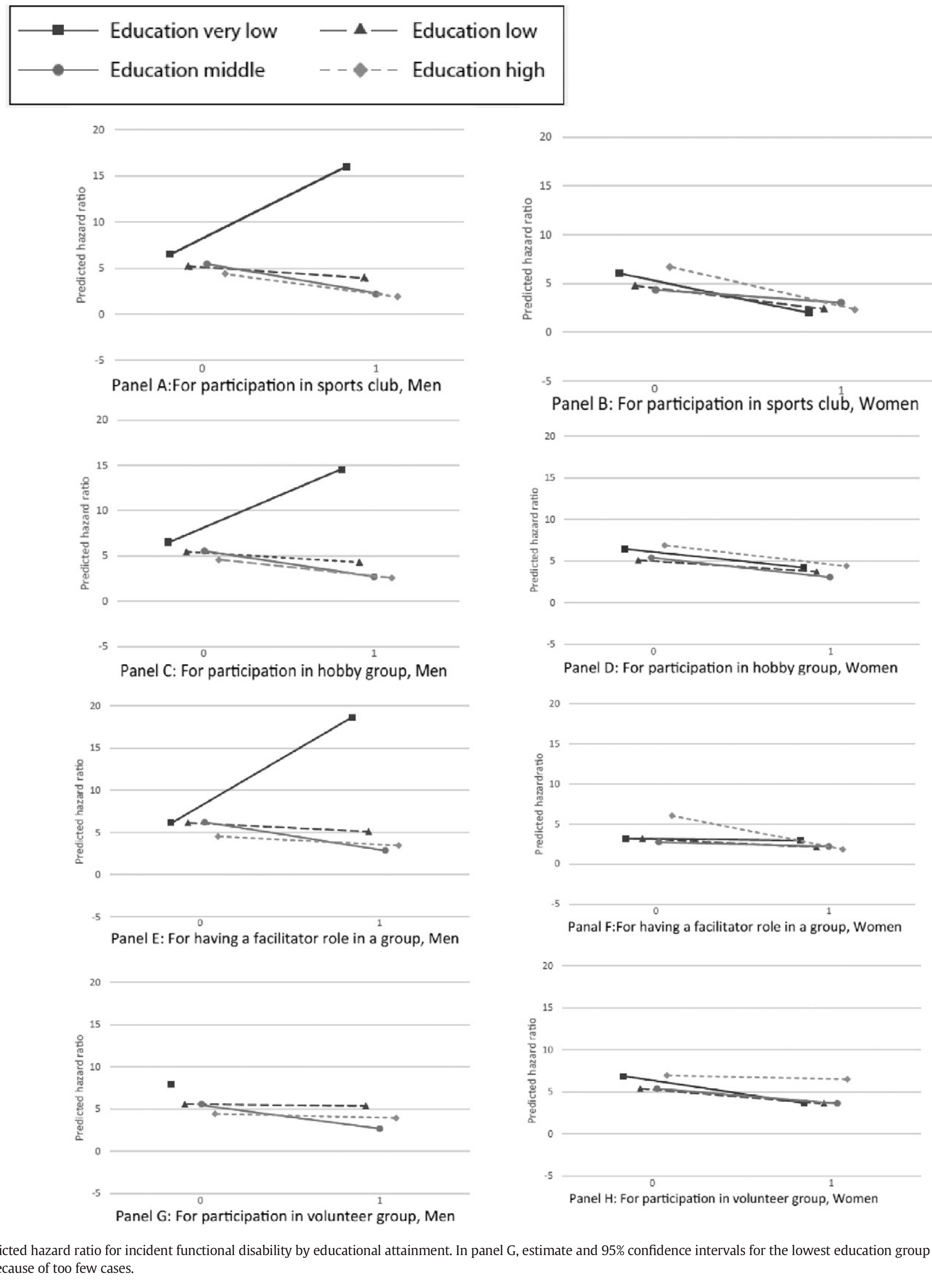

Fig. 1. Predicted hazard ratio for incident functional disability by educational attainment. In panel G, estimate and 95% confidence intervals for the lowest education group could not be obtained because of too few cases.

should not participate in sports, hobby, and volunteer groups. As suggested by the current study, given the smaller proportion of social participation among those in the low SES groups, community interventions such as designing participation programs and developing community venues may result in better health, regardless of SES. However, this may have a stronger magnitude for those with high SES. In addition, as shown in this study, in many cases individuals with a high SES may better take on facilitator roles.

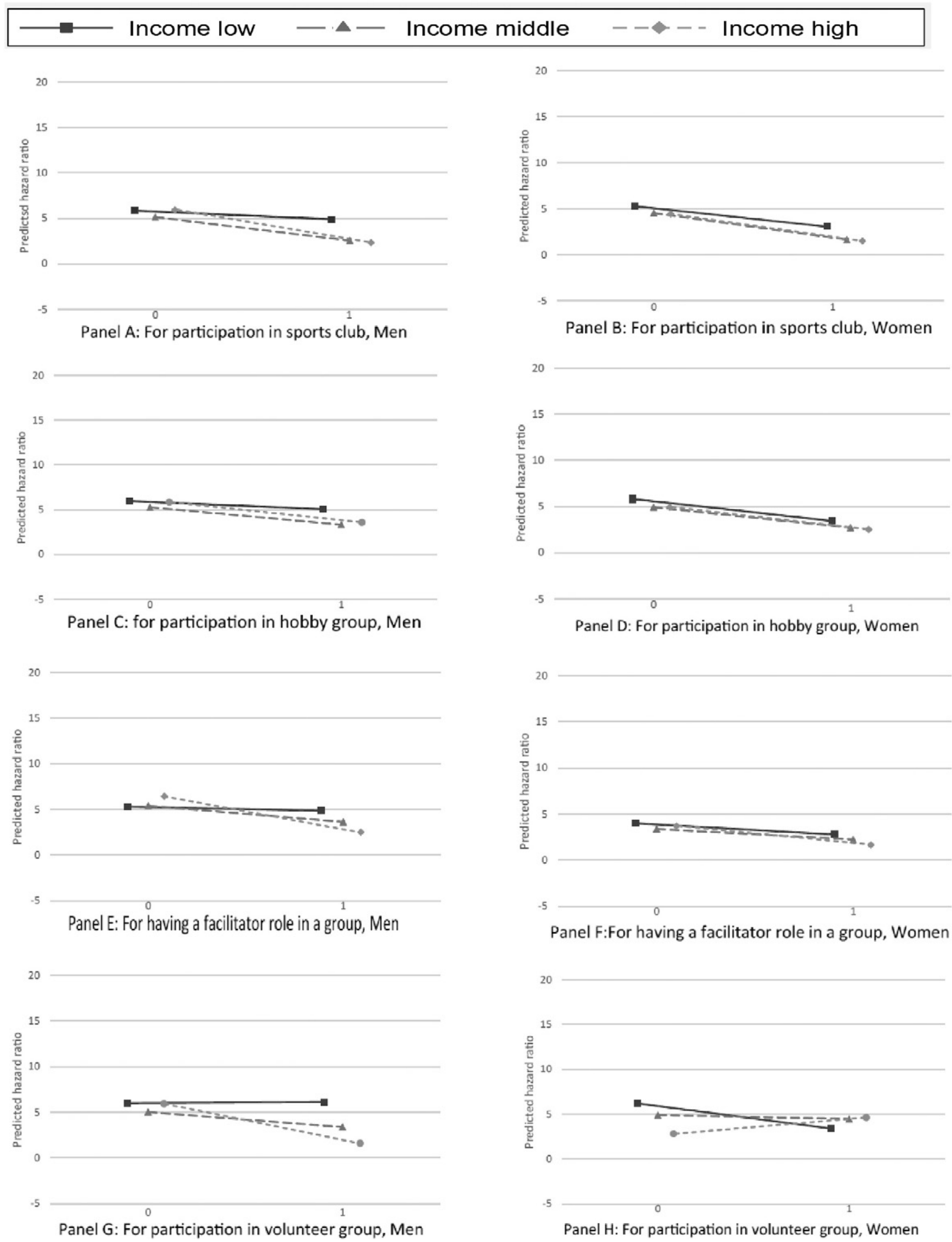

Fig. 2. Predicted hazard ratio for incident functional disability by income levels.

Conflict of interest

The authors' declare that there are no conflicts of interest.

Transparency document

The Transparency document associated with this article can be found, in online version.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at http://dx.doi.org/10.1016/j.ypmed.2016.05.006.

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