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Title

Social participation among older adults not engaged in full- or part-time jobs was positively associated with physical activity and less sedentary time

Authors

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Running title:

Social participation and physical activity

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43

44 **Abstract**

45

46 *Aim*

47 Social participation provides health benefits for older adults. However, there is the need to
48 identify whether higher social participation is associated with older adults being more
49 physically active and less sedentary (sitting time). We examined the associations of social
50 participation with physical activity, and sedentary time, in a population-based sample of
51 older Japanese adults.

52

53 *Methods*

54 A population-based, cross-sectional mail survey conducted in 2010 was used to collect data
55 on social participation, physical activity, sedentary time and socio-demographic
56 characteristics. Data were examined from 1146 community-dwelling, unemployed older
57 adults (mean age: 70.1 years, 43% men). Multivariate logistic regression analyses were
58 used to calculate odds ratios (ORs) for associations of social participation with physical
59 activity and total sedentary time; and, for associations with passive and mentally-active
60 sedentary (sitting) time.

61

62 *Results*

63 For both men and women, those with higher social participation were more physically
64 active (OR=2.10, [95% confidence interval (CI): 1.44-3.06] among men; OR=1.93,
65 [1.39-2.68] among women). Total sedentary time had significant associations among men
66 (OR=0.62, [0.42-0.90]), but not among women (OR=0.80, [0.58-1.11]). Social
67 participation was associated with less passive sedentary time (OR=0.55, [0.38-0.81] for
68 men; OR=0.72 [0.51-0.99] for women).

69

70 *Conclusions*

71 Promoting social participation among older adults may contribute to increasing physical
72 activity and reducing sedentary time, with potential benefits for chronic disease. Further
73 research is required to elucidate the deleterious and beneficial roles of passive and
74 mentally-active sedentary time for older adults.

75

76 Key-words: Aged, Cross-Sectional Studies, Motor activity, Sedentary Lifestyle, Social
77 participation

78

79

80 Introduction

81 Regular moderate-to-vigorous physical activity (MVPA) is related to lower risk of
82 all-cause and cardiovascular mortality^{1,2}, obesity³ and type 2 diabetes⁴. Recently,
83 sedentary behaviors (prolonged sitting as distinct from lack of MVPA) have been found to
84 be associated with increased cardio-metabolic risk⁵ and indices of poorer health⁶. There
85 are also preliminary findings suggesting that passive sedentary behaviors may be
86 deleterious and that mentally-active sedentary behaviors may be beneficial to health⁷.
87 Evidence to inform how increasing physical activity and decreasing sedentary behavior
88 may be employed as complementary strategies for reducing health risk is a research
89 priority^{8,9}.

90 The World Health Organization's Active Ageing: A Policy Framework includes community
91 participation as one of three basic pillars of active aging¹⁰. The Toronto Charter for
92 Physical Activity outlines the utility of physical activity to improve well being, physical
93 and mental health and to enhance social connectedness and quality of life¹¹. In this context,
94 enhancing social participation could be regarded as an effective active-aging intervention
95 strategy.

96 Several longitudinal studies have shown beneficial relationships of social participation
97 with all-cause mortality^{12,13} and social participation can provide older adults with benefits
98 such as better physical functioning¹⁴, maintaining cognitive performance¹⁵ and mental
99 well-being¹⁶. There is, however, limited evidence on whether higher social participation by
100 older adults is associated with being more physically active and having less sedentary time.
101 A study of 11,837 Swedish older adults showed low social participation to be the strongest
102 predictor of physical inactivity¹⁷. Further clarifying associations of social participation

103 with physical activity and sedentary time would provide evidence to develop more
104 informed health policies and initiatives for older adults in the future.
105 We examined the associations of social participation with physical activity, total sedentary
106 time and passive and mentally-active sedentary time, in a population-based sample of older
107 Japanese adults.

108

109

110 **Methods**

111 **Participants and data collection**

112 Detailed sampling procedures are described elsewhere¹⁸. Briefly, this population-based,
113 cross-sectional study was conducted in three Japanese municipalities; Bunkyo Ward in
114 Tokyo, Fuchu City in Tokyo, and Oyama Town in Shizuoka Prefecture. Older adults aged
115 between 65 and 74 years old were randomly selected from the registry of residential
116 addresses of each municipality, stratified by gender and by age (65-69 years and 70-74
117 years). In total, 2,700 community-living older adults were identified. Of those initially
118 identified, 2,046 returned the survey. After data cleaning, the data from 1,816 participants
119 were deemed valid for this study (response rate: 67.3%). Among these respondents, 670
120 engaged in full-time or part-time jobs were excluded to avoid potential confounding. The
121 final sample size was 1,146. All data was collected from February to March 2010. The
122 study received approval from the Tokyo Medical University Ethics Committee.

123

124 **Measures**

125 *Social Participation*

126 Social participation was assessed using a scale from the Japanese national survey
127 (Comprehensive Survey of Living Conditions)¹⁹. The questionnaire asks: “How often do

128 you engage in the following activities?” with answer choices of “hobby or cultural classes”,
129 “socials with friends or acquaintances”, “senior citizen clubs”, “volunteer groups”,
130 “community events or festivals” and “talking with family or friends”. Participation in each
131 activity could be identified as either: “(1) frequent”, “(2) often”, or “(3) seldom”. Levels of
132 social participation were calculated by summing these frequencies, ranging from 6 (highest
133 social participation) to 18 (lowest social participation). Then, they were dichotomized by
134 median values, separately by gender. (13 and below versus 14 and above for men; 12 and
135 below versus 13 and above for women).

136

137 *Physical Activity*

138 For MVPA, the Japanese version of the International Physical Activity Questionnaire
139 Short-version was used²⁰. Participants were asked to report the frequency and duration of
140 three types of physical activity: vigorous-intensity, moderate-intensity (excluding walking),
141 and walking. Total time spent in MVPA, including walking, was calculated by adding these
142 three activities together. For the present analyses, MVPA was dichotomized at the median
143 into lower (<360 min/week for men, ≤300 min/week for women) and higher (≥360
144 min/week for men, >300 min/week for women). This classification was used because a
145 large proportion of participants (about 75%) reported 150 min/week or more of MVPA, the
146 current recommendation for older adults²¹.

147

148 *Sedentary behaviors*

149 Leisure time sedentary behaviors (LTSBs) were determined from participants’ self-reported
150 frequency and average duration (minutes/day) over the past 7 days. Participants were asked
151 about five types of LTSBs – television viewing, computer use, reading books or
152 newspapers, listening or talking while sitting, and sitting around. These question items

153 were translated into Japanese from an Australian questionnaire on LTSBs²². The
154 questionnaire is known to have good test-retest reliability (ICC= 0.56–0.82) and acceptable
155 validity (correlation with a three-day log: $r = 0.2-0.4$)²². For analysis, total time of LTSBs
156 was dichotomized at the median into lower (<1,900 min/week for men, $\leq 1,740$ min/week
157 for women) and higher (1,900 min/week for men, >1,740 min/week for women).
158 In our previous study, sedentary behavior was able to be classified into two distinct types:
159 passive sedentary behaviors (consisting of “television viewing”, “sitting around”, and
160 “listening or talking while sitting”) and mentally-active sedentary behaviors (consisting of
161 “computer use” and “reading books or newspapers”)⁷. These two categories of sedentary
162 time were calculated and dichotomized at the median into lower (<1,340 min/week of
163 passive sedentary time, <420 min/week of mentally-active sedentary time among men;
164 <1,290 min/week of passive sedentary time, <300 min/week of mentally-active sedentary
165 time among women) and higher ($\geq 1,340$ min/week of passive sedentary time, ≥ 420
166 min/week of mentally-active sedentary time among men; $\geq 1,290$ min/week of passive
167 sedentary time, ≥ 300 min/week of mentally-active sedentary time among women).

168

169 *Covariates*

170 Age and gender were obtained from the registry of residential addresses of each
171 municipality. Educational attainment (years of education) and living arrangement (living
172 with others, living alone) were obtained through self-report by each respondent.
173 Participants were categorized according to education (up to high school [< 13 years] and
174 college degree or more [≥ 13 years]).

175

176 **Statistical Analysis**

177 Multivariate logistic regressions were employed to calculate the odds ratios (ORs) and

178 95% confidence intervals (95% CI) for the associations of higher social participation with
179 higher total LTSB time. ORs were calculated, adjusting for age and municipality
180 (minimally-adjusted model), then further adjusting for living arrangement and education
181 (fully-adjusted model). In the fully-adjusted model, MVPA or total time of LTSB were also
182 adjusted in estimating ORs of higher MVPA or higher LTSB, respectively.

183

184 Finally, the ORs for associations of higher social participation with higher time in each
185 LTSB category (passive and mentally-active) were calculated, adjusting for age,
186 municipality, living arrangement, education, and MVPA. Similar analyses were conducted
187 by city of residence.

188

189 Before the multiple logistic regression analyses, Hosmer-Lemeshow's goodness of fit test
190 was calculated, with the null hypothesis being that the distribution fits the data. All
191 statistical analyses were conducted separately by gender using STATA software (version
192 12); the level of significance was set at $p < 0.05$.

193

194 **Results**

195 Table 1 shows characteristics of participants. The sample consisted of 43% men, and the
196 mean age of participants was 70.1 years. Higher social participation was significantly
197 associated with physical limitation status.

198

199 Table 2 shows the summary statistics for LTSB and MVPA by social participation status.
200 For both genders, those with higher social participation spent about 50% more time in
201 MVPA and 10% to 20% less time for LTSB. Regarding specific sedentary behaviors;
202 television viewing time, which accounted for 70% of the total passive sedentary time, was

203 significantly associated with social participation. Among men, time “doing nothing
204 special” was also associated with lower social participation, whereas, time for “computer
205 use” was longer among men with higher social participation.

206

207 INSERT TABLES 1, 2 & 3 ABOUT HERE

208

209

210 Table 3 shows the adjusted odds ratios for higher MVPA and lower total LTSB time by
211 social participation status. For both genders, those with high social participation were more
212 physically active (OR: 2.10, [95%CI: 1.44-3.06] among men, OR: 1.93, [1.39-2.68] among
213 women) than those with lower participation. Social participation was inversely associated
214 with sedentary time among men (OR: 0.62, [0.42-0.90]), but not among women (OR: 0.80,
215 [0.58-1.11]). Men with higher social participation had significantly lower odds of passive
216 sedentary behaviors (OR: 0.55, [95%CI: 0.38-0.81]), but not significantly higher odds of
217 mentally-active sedentary behaviors (OR: 1.36, [0.91-2.02]). Women with higher social
218 participation have significantly lower odds for passive sedentary behaviors (OR: 0.72,
219 [0.51-0.99]).

220

221 Table 4 represents the adjusted odds ratio for MVPA and LTSB by city of residence. In
222 each city of residence, those with higher social participation were physically active than
223 those with lower participation. Among men in urban area, social participation was
224 positively associated with inversely sedentary behaviors (OR: 0.41, [0.18-0.91]), and
225 associated with mentally active sedentary behaviors (OR: 3.27, [1.24-8.63]). In addition,
226 passive sedentary time were inversely associated with social participation among those in
227 regional area (OR=0.43, [0.23-0.82] for men; OR=0.56 [0.31-1.00] for women). Whereas,

228 no clear association was observed between sedentary time and social participation among
229 those in suburban area.

230

231 **Discussion**

232 Older Japanese adults with higher social participation were more likely to be physically
233 active. Significant inverse associations between total sedentary time and social
234 participation status were observed among men, but not women. However, for both men and
235 women, higher social participation was associated with less passive sedentary time.

236

237 With older adults who have higher social participation being more likely to have physically
238 active life-styles, this study provides supportive evidence for health policies aimed at
239 social participation^{10,23}. The results of our study suggested that promoting social
240 participation may contribute to reducing sedentary time, simultaneously. There is as yet no
241 evidence on effective, population-based countermeasures for reducing sedentary time⁵. In
242 this context, promoting social participation could be one practical strategy not only to
243 promote physical activity, but also to reduce sedentary time for older adults.

244

245 There are several possible mechanisms to explain why older adults with higher social
246 participation are more physically active and less sedentary. Obviously, social participation
247 itself provides more opportunities to go outside. Thus, older adults with higher social
248 participation may walk more to join activities, and may spend less time sitting at home. In
249 addition, a Japanese longitudinal study showed that social participation improves older
250 peoples' mental health²⁴, which may promote their physical activity²⁵. Furthermore, social
251 participation has been reported to improve access to social support²⁶, which may also
252 contribute to increased physical activity²⁷.

253

254 Interestingly, older men with higher social participation spent more time in computer use.
255 Speculatively, computer use may help in contacting friends or gathering information,
256 which may provide more opportunities for older adults to have engagements outside of the
257 home ²⁸. Whereas, computer use has been treated as an unfavorable behavior among
258 younger or middle-aged adults ^{29, 30}. However, computer use may be a favorable attribute
259 for older adults, in that it may promote social participation.

260

261 A strength of our study is that we recruited community-dwelling older adults
262 randomly-selected from three different localities (urban, suburban, and regional), and
263 assessed the association between multiple sedentary behavior and several health-related
264 attributes. The response rate to our survey and the availability of complete data was
265 acceptable (59%).

266

267 A notable finding was that social participation was associated with passive sedentary time
268 more than with total sedentary time, especially among women. Targeting passive sedentary
269 time rather than total sedentary time may be more useful in initiatives to promote older
270 adults' health ⁷. Certainly, we found that total sedentary time was not associated with social
271 participation status among women. However, this would not justify a conclusion that
272 promoting social participation may not contribute to reducing chronic diseases related to
273 sedentary behavior among women, because passive sedentary time was significantly
274 associated with social participation. Future studies are warranted to focus not only on
275 overall sitting time, but also on subtypes of sedentary behavior in examining the health
276 impacts of sitting ⁷.

277

278 In conclusion, promoting social participation among older adults may contribute to
279 increasing physical activity and reducing sedentary time, with potential benefits for chronic
280 disease. Further research is required to elucidate the deleterious and beneficial roles of
281 passive and mentally-active sedentary time for older adults.

282

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289

290 **Disclosure statement**

291 The authors declare no conflict of interest.

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296

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Table 1. Characteristic of participants

	Men				p	Women				p
	Social Participation Higher		Social Participation Lower			Social Participation Higher		Social Participation Lower		
	n	(%)	n	(%)		n	(%)	n	(%)	
n	245	(50.1%)	244	(49.9%)		321	(48.9%)	336	(51.1%)	
Age group (years)					n.s.					n.s.
65-69	125	(49.8%)	126	(50.2%)		162	(47.2%)	181	(52.8%)	
70-74	120	(50.4%)	118	(49.6%)		159	(50.6%)	155	(49.4%)	
City of residence					n.s.					n.s.
Central capital (Bunkyo)	68	(58.6%)	48	(41.4%)		94	(47.0%)	106	(53.0%)	
Suburban (Fuchu)	94	(46.3%)	109	(53.7%)		112	(48.7%)	118	(51.3%)	
Rural (Oyama)	82	(48.2%)	88	(51.8%)		115	(50.7%)	112	(49.3%)	
Living arrangements					n.s.					n.s.
Living with others	223	(51.3%)	212	(48.7%)		282	(49.1%)	292	(50.9%)	
Living alone	22	(40.7%)	32	(59.3%)		39	(47.0%)	44	(53.0%)	
Physical limitations					<0.05					<0.001
No	234	(51.8%)	218	(48.2%)		308	(51.1%)	295	(48.9%)	
Yes	11	(29.7%)	26	(70.3%)		13	(24.1%)	41	(75.9%)	
Body mass index (kg/m ²)					n.s.					n.s.
<25	199	(50.6%)	194	(49.4%)		264	(49.3%)	272	(50.7%)	
≥25	46	(47.9%)	50	(52.1%)		57	(47.1%)	64	(52.9%)	
Educational attainment (education years)					n.s.					n.s.
College degree or more (≥13)	54	(48.2%)	58	(51.8%)		90	(53.6%)	78	(46.4%)	
Up to high school (< 13)	191	(50.7%)	186	(49.3%)		231	(47.2%)	258	(52.8%)	

p-values were calculated by chi-square test, S.D.: standard deviation

Table 2. Durations of physical activity and sedentary time by gender and by social participation status (hours/day)

	Social Participation Higher				Social Participation Lower				p
	Mean	(S.D.)	Median	(25th-75th percentile)	Mean	(S.D.)	Median	(25th-75th percentile)	
Men									
Moderate-to-vigorous physical activity time	1.34	(1.39)	1.00	(0.42-1.71)	0.93	(1.15)	0.57	(0.14-1.33)	<0.001
Sedentary Time (<i>Total</i>)	4.98	(3.08)	4.57	(2.93-6.57)	5.90	(3.63)	5.86	(3.43-8.01)	<0.001
<i>(Passive Sedentary Behavior)</i>									
TV viewing	2.74	(2.09)	2.00	(1.29-4.00)	3.50	(2.43)	3.00	(2.00-5.00)	<0.001
Listening to music or talking	0.58	(0.82)	0.36	(0.00-0.86)	0.58	(0.89)	0.14	(0.00-1.00)	n.s.
Doing nothing special	0.48	(1.16)	0.00	(0.00-0.48)	1.08	(1.76)	0.12	(0.00-2.00)	<0.001
<i>(Mentally-active sedentary behavior)</i>									
Computer use	0.55	(1.13)	0.00	(0.00-0.57)	0.30	(0.85)	0.00	(0.00-0.05)	<0.001
Reading books or newspaper	1.03	(1.01)	1.00	(0.43-1.16)	1.03	(1.20)	0.75	(0.17-1.42)	n.s.
Women									
Moderate-to-vigorous physical activity time	1.39	(1.83)	0.85	(0.38-1.57)	0.89	(1.23)	0.50	(0.19-1.08)	<0.001
Sedentary Time (<i>Total</i>)	4.50	(2.96)	4.07	(2.47-6.29)	5.17	(3.41)	4.76	(2.58-7.41)	<0.05
<i>(Passive Sedentary Behavior)</i>									
TV viewing	2.73	(2.06)	2.00	(1.29-4.00)	3.21	(2.52)	3.00	(1.50-4.00)	<0.05
Listening to music or talking	0.74	(0.94)	0.50	(0.00-1.00)	0.73	(0.88)	0.50	(0.00-1.00)	n.s.
Doing nothing special	0.43	(1.30)	0.00	(0.00-0.43)	0.55	(1.47)	0.00	(0.00-0.50)	n.s.
<i>(Mentally-active sedentary behavior)</i>									
Computer use	0.14	(0.48)	0.00	(0.00-0.00)	0.12	(0.43)	0.00	(0.00-0.00)	n.s.
Reading books or newspaper	0.88	(0.83)	0.67	(0.33-1.00)	0.91	(1.03)	0.50	(0.20-1.00)	n.s.

p-values were calculated by ranksum test, S.D.: standard deviation

Table 3. Associations of social participation categories with physical activity and with sedentary time (multivariate logistic regression)

Social Participation		Minimally-adjusted Model			Fully-adjusted Model		
		OR	(95% C I)	p	OR	(95% C I)	p
<i>Physical Activity Time</i>							
Men	Lower	(1.00)			(1.00)		
	Higher	2.18 ^{a)}	(1.50-3.16)	<0.001	2.10 ^{b)}	(1.44-3.06)	<0.001
Women	Lower	(1.00)			(1.00)		
	Higher	2.07 ^{a)}	(1.59-2.85)	<0.001	1.93 ^{b)}	(1.39-2.68)	<0.001
<i>Sedentary Time (Total Sedentary Time)</i>							
Men	Lower	(1.00)			(1.00)		
	Higher	0.59 ^{a)}	(0.41-0.86)	0.005	0.62 ^{c)}	(0.42-0.90)	0.013
Women	Lower	(1.00)			(1.00)		
	Higher	0.79 ^{a)}	(0.58-1.08)	0.140	0.80 ^{c)}	(0.58-1.11)	0.186
<i>(Passive Sedentary Time)</i>							
Men	Lower	(1.00)			(1.00)		
	Higher	0.53 ^{a)}	(0.37-0.77)	0.001	0.55 ^{c)}	(0.38-0.81)	0.003
Women	Lower	(1.00)			(1.00)		
	Higher	0.66 ^{a)}	(0.48-0.89)	0.008	0.72 ^{c)}	(0.51-0.99)	0.046
<i>(Mentally-Active Sedentary Time)</i>							
Men	Lower	(1.00)			(1.00)		
	Higher	1.51 ^{a)}	(1.04-2.20)	0.029	1.36 ^{c)}	(0.91-2.02)	0.135
Women	Lower	(1.00)			(1.00)		
	Higher	1.33 ^{a)}	(0.97-1.81)	0.074	1.17 ^{c)}	(0.83-1.63)	0.360

Adjustments for covariates

a) age and city of residence

b) age, city of residence, educational attainment, living arrangement, body mass index, physical limitation and total sedentary time

c) age, city of residence, educational attainment, living arrangement, body mass index, physical limitation and MVPA

BMI: body mass index, MVPA: moderate-to-vigorous physical activity, OR: odds ratio, CI: confidence interval

Table 4. Associations of social participation categories with physical activity and with sedentary time by city of residence

Social Participation	Bunkyo Ward (Urban)			Fuchu City (Suburban)			Oyama Town (Regional)		
	OR	(95% C I)	p	OR	(95% C I)	p	OR	(95% C I)	p
<i>Physical Activity Time</i>									
Men	Lower	(1.00)		(1.00)			(1.00)		
	Higher	2.00	(0.88-4.54)	0.099	2.55	(1.35-4.82)	0.004	2.08	(1.14-3.80)
Women	Lower	(1.00)		(1.00)			(1.00)		
	Higher	1.76	(0.97-3.18)	0.061	1.88	(1.08-3.26)	0.025	2.17	(1.21-3.90)
<i>Sedentary time (Total Sedentary Time)</i>									
Men	Lower	(1.00)		(1.00)			(1.00)		
	Higher	0.66	(0.29-1.46)	0.300	0.82	(0.42-1.62)	0.575	0.49	(0.26-0.90)
Women	Lower	(1.00)		(1.00)			(1.00)		
	Higher	0.97	(0.54-1.76)	0.926	0.75	(0.43-1.30)	0.302	0.70	(0.39-1.26)
<i>(Passive Sedentary Time)</i>									
Men	Lower	(1.00)		(1.00)			(1.00)		
	Higher	0.41	(0.18-0.91)	0.028	0.94	(0.48-1.83)	0.862	0.43	(0.23-0.82)
Women	Lower	(1.00)		(1.00)			(1.00)		
	Higher	1.01	(0.55-1.85)	0.973	0.63	(0.36-1.10)	0.106	0.56	(0.31-1.00)
<i>(Mentally-Active Sedentary Time)</i>									
Men	Lower	(1.00)		(1.00)			(1.00)		
	Higher	3.27	(1.24-8.63)	0.017	0.88	(0.43-1.78)	0.716	1.34	(0.72-2.47)
Women	Lower	(1.00)		(1.00)			(1.00)		
	Higher	1.32	(0.74-2.38)	0.351	1.18	(0.67-2.06)	0.570	1.03	(0.57-1.86)

Odds ratios were adjusted by age, city of residence, educational attainment, living arrangement, body mass index, physical limitation and MVPA
 BMI: body mass index, MVPA: moderate-to-vigorous physical activity, OR: odds ratio, CI: confidence interval